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Unit Wall Concrete Building Construction, Fort Crockett, Texas

By R. C. Hardman*

During the past three years the U. S. War Department has had under construction a new coast artillery post at Fort Crockett, Galveston, Tex., which comprised, in part, the construction of 31 reinforced-concrete buildings. Ten of these were constructed under what is known as the "Aiken System of Flat Wall Construction."† The buildings so built were as follows: four double sets of officers' quarters, quarters for the commanding officer, quartermaster's storehouse, quartermaster's workshops, fire station, bakery and a post exchange and gymnasium. These buildings cost when completed the sum of $145,644.

This system of construction, which has been in use for several years, is, as its name implies, a system of flat wall construction; the wall when thoroughly set being raised from a nearly horizontal position to a vertical one by means of screw jacks. The necessary apparatus consists of a trussed beam having cantilever ends, supported near one end upon an A-frame and near the other end upon a telescopic screw jack, both connections being made by pins so that the beam is free to move when the telescopic jack is elongated. The telescopic jack is connected to the base of the A-frame by a pin, leaving it free to move at its base.

This apparatus is shown in its essential features in Fig. 2, *B* being the beam supported by pin connection *D* upon frame *A* and by pin connection *C* upon telescopic jack *F*, which in turn is connected to frame *A* at *E* by a similar pin. The beam and frame are built up of structural shapes. The entire apparatus is known familiarly as a "jack."

In operation the beam *B* revolves from its nearly horizontal position to a final vertical one about the point *D*, being impelled by the elongation of the screw jack, substantially as shown by the dotted lines in Fig. 2.

In the construction of a wall a number of jacks are used, they being spaced so as to secure equal loadings, to their maximum capacity, if possible, without at the same time being placed so far apart as to necessitate costly lagging to prevent excessive deflections between them. On an ordinary wall this spacing will be about 10 ft., although the jacks will not be working at their maximum. The jacks are placed in perfect alignment and in position relative to the foundation wall so that the finished wall when raised will be in its proper position. The jacks are also aligned vertically as well as horizontally in order that the drive shaft which engages each screw jack at *G*, Fig. 2, will be perfectly straight and true. The screws are actuated by a worm gearing driven by a hexagonal shaft, upon which is placed, near the middle jack, a drive wheel connected to an engine or motor by belt or cable as desired.

Upon the top chord of the beams, which is made up of two angles back to back, is placed the centering, or lagging, which is secured to the beam by bolts and supported between them by shoring. At intervals along the lagging over each beam are placed short pieces of 3x3-in. angles (*H*, Fig. 2) which are later embedded in the concrete and serve to prevent the wall from slipping on the forms when raised to a vertical position. At the lower end of the top chord of each beam is a piece of angle (*I* Fig. 2) bent up to engage the lower bulkhead of the form work and to serve the same purpose as the small angles mentioned above. It is necessary to break the bulkhead around this shoe and insert wedges, so that when the wall is about to be raised the bulkhead may be taken out.

Upon the lagging, which may be of 2-in. material, or heavier, are placed all window and door frames, nailing blocks, bolts, anchors and other fastenings. Then all water and drainage pipes, electric conduits, boxes, and other necessary electrical work are put in place, and lastly the reinforcement. When ready to receive the concrete, the wall, with everything required in it, is in full view for checking and inspection, matters which are very difficult with a wall poured by the usual method. Concrete may then be placed in precisely the same manner as on a floor. If a hollow wall is desired it may be secured by putting in a layer of concrete, then a layer of sand of the thickness of the desired air space and covered with cheap building paper, covering the whole with another layer of concrete of the proper thickness. If any ornamental work is desired it may be cast separately, put on the lagging and the concrete placed around it.

After the wall has set sufficiently, usually about five days, the shoring is removed from between the jacks, guy wires

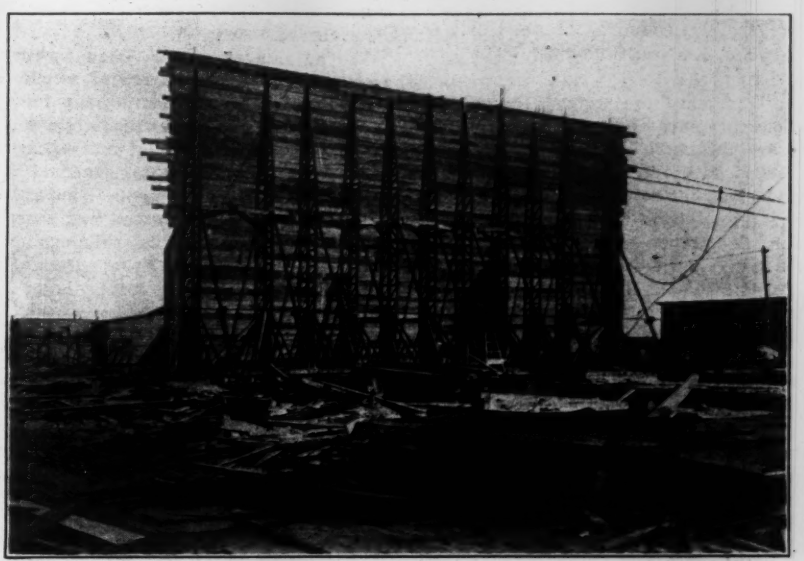

Fig. 1. View of Front Wall of Building at Fort Crockett Under Construction

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†See Engineering News, Sept. 17, 1908, p. 313.

or cables are secured to the top of the wall and the whole is raised to a vertical position. This operation requires from two to eight hours, dependent upon the size and weight of the wall. Extreme caution must be used during the raising, and a constant inspection of the jacks be kept up; especially so when the wall has

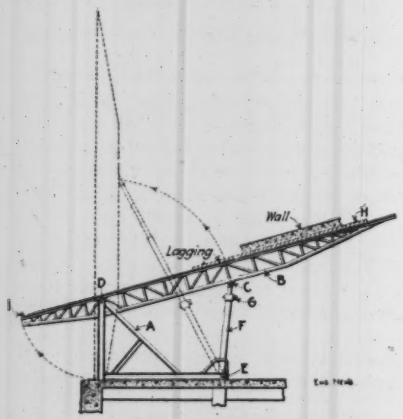


FIG. 2. DETAIL OF FRAME FOR BUILDING AND RAISING CONCRETE WALL

nearly reached the vertical, as a very slight movement past the vertical will throw the wall. When the wall has reached its proper position, the guys are made fast, the screws are detached at *C* and turned back to their original position, the beams are detached at *D* and the frame *A* withdrawn. Then the beams are unfastened from the lagging and lowered, and the lagging stripped from the wall.

Fig. 1 shows a stage in the construction of the post exchange and gymnasium, 56x94 ft. in plan, front and rear walls 31 ft. in height and end walls 49 ft. in height. All walls were 12 in. in thickness, the front wall having a small pediment 24 in. thick in addition. Thus the front wall had a weight of approximately 220 tons, including lagging, etc. The halftone gives an excellent rear view of one of the end walls raised, showing particularly well the placing of the jacks and the driving mechanism. The rear wall of this building was erected by the usual form method, and the writer was informed that the form work cost, for labor, approximately 180% more than that for the front wall, the walls being very similar.

Methods of tying walls together at the corners and angles are shown in Fig. 3, as well as horizontal joints, floor connections and other details. If the building under construction has intermediate floors of concrete the exterior walls are erected to the full height—say, two or three stories—at one operation and the floors are built in subsequently by the usual methods. Fig. 3 shows the manner in which provision is made for the support of the floor system by the wall. When the forms for the wall are being prepared upon the jacks, as previously described, timbers of the proper size, notched and bored for the reinforcing metal of the wall, are placed thereon; these, when removed after the wall is erected forms grooves or chases (shown at *A* in Fig. 3) for the reception of the concrete floor slab. The ends of all beams are also laid out on the wall lagging and boxes of suitable sizes are placed thereon. These, when removed, form pockets or recesses for the subsequent placing of the beam ends. In order to tie the walls and floor together, bent rods (90°) are placed in the wall forms and emerge from the floor chase at the proper distance above the floor lagging to engage the floor reinforcement, to which it is later wired. Thus, when the walls of the building have been erected, there will be a continuous chase around the interior with pockets for the beam ends at suitable intervals and rods to which to tie the floor reinforcement. Forms for the columns, beams and floor slabs are erected in the usual manner and the concrete poured.

The advantages of the Aiken System are its low form cost, speed of erection and the possibility of securing any form of surface treatment desired while the base is still green, which, of course, cannot be secured when the form method is used. Its disadvantage is the comparative weakness of the corners and other connections. However, in buildings of

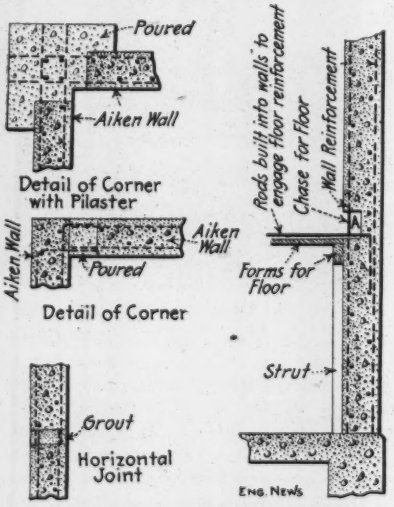


FIG. 3. DETAILS OF WALL AND FLOOR CONNECTIONS

one, two or three stories this is not especially serious, as by proper designing all probable strains can be well taken care of. The system lends itself particularly well to a pilaster treatment of the exterior, the pilasters serving to cover the joinings of the wall sections.

The contractors for this work were James A. McGonigle & Son, of Leavenworth, Kan.; Capt. P. Whitworth, U. S. Army, was Constructing Quartermaster, and the writer served the War Department in the capacity of Superintendent of Construction.

A Summary of Eight Years' Work on the Panama Canal

Eight years ago on May 4 the United States government assumed the gigantic engineering undertaking of building a canal across the Isthmus of Panama. This was 23 years after work had been inaugurated by the French under De Lesseps, and after nearly $400,000,000 had been expended by the French companies.

For the rights of the French company the United States paid $40,000,000. This amount paid for some 78,000,000 cu.yd. of excavation and a great variety of equipment, some of which has been in continuous use since, but by far the greater part has been sold as scrap metal. Of the 78,000,000 cu.yd. excavated by the French only 30,000,000 cu.yd. came within the canal prism as it has ultimately been constructed.

On May 1, 1912, under the direction of American engineers, 171,250,000 cu.yd. of material had been excavated and less than 24,250,000 cu.yd. remained to be removed, which is being done at the rate of 2,500,000 cu.yd. a month. The excavation of Culebra cut is more than 90% completed. Each year has seen a greater record made in the work of excavation than that of any previous year. From May 1, 1911, to May 1, 1912, the amount of material removed was nearly 16,500,000 cu.yd., and much of this was rock.

The lowest steam shovel cut is now less than 17 ft. above the bottom of the channel at Culebra, the summit of excavation. From this point the cut runs to final grade at both ends. At the north end the excavation is practically completed from the Chagres River as far south, toward Culebra, as Las Cascadas; and at the south end the trench is nearly to grade for a mile or more. The greater part of what remains to be excavated lies between Empire and Gold Hill, a distance of about two miles.

On May 1 the great concrete locks at Gatun and Pedro Miguel were almost ready except for the gates, and the locks at Miraflores were more than 65% completed, with the work advancing at the rate of 20,000 cu.yd. of concrete a week placed.

At Gatun, for the locks and dam nearly 2,000,000 cu.yd. of concrete have been made and placed since the work was begun. At the Pedro Miguel locks the total placed is about 840,000 cu.yd. and at Miraflores, nearly 900,000 cu.yd. This makes a grand total of about 3,700,000 cu.yd. of concrete, or enough to pave the

entire surface of the Island of Manhattan to a depth of 2¼ in., or to make a single cube 464 ft. on a side.

The manufacture of the great steel gates was started in October, 1910, and their erection on the Isthmus began the following June. On Mar. 31, 1912, the erection of these 58,000 tons of structural steel into 46 pairs of lock gates was already one-quarter completed, a task which entails the driving of 6,000,000 field rivets. The contract for machinery for operating the gates was let in June, 1911, and erection was begun in January, 1912; at this writing, one gate at Gatun has already been fully equipped and successfully operated.

Of the rising stem valves, 10 ft. 8 in. wide and 18 ft. 10 in. high, which control the flow of water into the lock chambers, two had already been put in place on Mar. 31, 43 were ready for erection and the contract for the entire 134 had been let, a total of 1876 tons of metal. The installation of the special cylindrical valves which control the flow of water from the center culverts into the lock chambers is practically completed except for a few in the Miraflores locks. There are 120 valves of this type. The contract for the electric motors operating the valves has been let and their erection is under way.

The erection of the first of the six great emergency steel dams which will guard the upper levels of the locks in case of accidents to the gates has been begun at Gatun and the fabrication of the other five is under way in the United States. The design and operation of these dams was described in ENGINEERING NEWS of July 22, 1909. Each is built essentially of a pair of cantilever trusses, 263 ft. long, so pivoted that their longest arm may be swung across the 110-ft. locks and the wicket girders which form the dam dropped into place. The total weight of the six dams is 12,000 tons.

The fender chains for preventing unmanageable ships from colliding with the gates and hydraulic apparatus for operating them are in the process of manufacture. The chains are being made at the Boston Navy Yard and one of them has been completed and recently passed a successful test. The fenders for the approach walls, which were described in ENGINEERING NEWS of Nov. 2, 1911, will soon be ready to place in position.

Practically every detail of the lock operation has been worked out. The contract for one of the electric towing locomotives, of which there are to be 40, has been let and it is now being built in the United States. The electrical apparatus required to operate the locks includes 944 motors, all of 220-volt, 25-cycle, 3-phase alternating-current type, and of these 803 have already been contracted for. The contract for the hydro-electric plant at Gatun, which will furnish most of the power for the operation of the locks, has been let and work on the station building will soon be started.

The Gatun dam is rapidly nearing completion. As already noted in ENGINEERING NEWS, the concrete spillway is so far completed as to make possible the closing of the sluice gates, and in the course of a few months Gatun Lake will be at an elevation of 50 ft. above sea level. The hydraulic fill on the east section of the great earth dam has been completed and the placing of the dry fill on this section to its final elevation of 107 ft. above sea level is progressing rapidly. At the same time the work of paving the south face is well under way. On the west section of the dam, three suction dredges are now completing the hydraulic fill and dry material from borrow pits is being added. The west dam at Miraflores has been practically completed. The east dam there is to be a concrete wing wall and has not yet been begun. The work on the west dam at Pedro Miguel is also practically completed.

The terminal plans and work on them were briefly described in ENGINEERING NEWS of May 30. Work on the fortifications to guard the entrances of the canal was begun during the present year. Plans for lighting the canal by beacons and buoys are completed and approved, and work on them has also been begun. Besides all this work in constructing the canal proper, almost the entire line of the Panama R.R. has been relocated and the work of rebuilding on the new location is nearly completed.

Thus at the end of eight years of American industry the end of the great undertaking, without failure in any detail, is actually in sight. Already laborers are being discharged and greatest pressure of work has passed.

To accomplish this the United States had expended up to Mar. 31, 1912, $252,000,000, including the payments to the French company and the Republic of Panama. Excluding this $50,000,000, we have just half the amount expended in 23 years by De Lesseps in a futile attempt to accomplish much less of an undertaking.

The actual amount which has been charged to the department of construction and engineering during the eight years of American work, is $144,600,000. The expenses of the department of civil administration, which includes also the maintenance and operation of public works in the Canal Zone and in the cities of Colon and Panama, the construction and repair buildings and the survey of the Canal Zone amounted to $5,515,000. The department of sanitation, which has contributed in so large a measure to the success of the enterprise, had expended nearly $14,500,000. General items, which include the payments to the French company and to the Republic of Panama, the construction of water-works and sewerage in the cities of Colon, Panama and in the Canal Zone, the Panama R.R. expenses, the cost of terminals, lands purchased, etc., amounted to $86,720,000.

Fire Losses in 1911 in the United States amounted to $158,392,630, according to figures given by President George W. Babb, of the National Board of Fire Underwriters, at its 46th annual meeting in New York, May 23. The figure given represents the fire losses paid by 180 fire insurance companies. Mr. Babb stated that dividends to the stockholders in these companies were made possible only by returns from the investment of surpluses in other lines of securities. The per capita loss in 298 principal cities was $2.02. In Germany it was 21c., in England 53c., France 81c. and in Austrian cities only 8c.

A Wireless Telegraph Compass has been devised by the Deutsche Betriebsgesellschaft für drahtlose Telegraphie (Telefunken company), of Berlin, Germany. For this an arrangement of directive and undirective antennæ is needed. Of the former there are 32 equally spaced about the arc of a circle of such diameter that two opposite antennæ are about a half a wave length apart with the wave length used for directive signals. The undirective antenna stands in the center. This arrangement is described in the London Electrician of May 24, 1912. Immediately before beginning work the transmitting apparatus is connected to the undirective antenna and a short impulse known as the "time signal" is sent out. Then the transmitting apparatus is connected automatically with a pair of opposite antennæ and a short impulse or dot is sent out at regular time intervals from each pair of directive antennæ. This impulse is the same for all, but the directive signals begin with the north-south pair of antennæ and then continue in a clockwise direction at constant time intervals. The sounds heard by the wireless operator on board ship in his ordinary receiver are loudest when the directive signal is sent out from the pair of antennæ which is perpendicular to the line between ship and station and weakest when sent out from the pair of antennæ in line. In the first case, the waves sent from the two opposite antennæ reinforce each other and in the second case they interfere, being half a wave length apart. The ship's wireless operator is furnished with a special stop watch which has its dial graduated in 32 divisions, beginning with north, so that the starting point of the stop watch is the same as the starting point of the sending apparatus. The operator hears the time signal of the shore station and starts the stop watch at that moment. When he hears the minimum sound he stops the watch and the hand then shows the direction of the shore station from which this minimum sound was received. Ten complete measurements of this direction can be made in five minutes. If two of these shore stations are available then two direction determinations may be taken by the wireless operator and drawn on the chart to give the position of his ship. The company proposes to erect a chain of these stations every 25 to 50 miles around the coast of Germany.

Canadian Transcontinental Railway

A transcontinental railway, extending from the Atlantic to the Pacific as a complete new line, and not merely linking up existing lines, was the bold project undertaken a few years ago by the Canadian Government. It was undertaken for the purpose of developing the country, and especially of developing the great wheat-growing territory of the northwest, and providing ample capacity for handling the enormous product which this territory will have when under cultivation. The construction of the western end (beyond Winnipeg) was turned over to a company (the Grand Trunk Pacific Ry.), but that of the eastern section was taken in hand directly by the government, which appointed a special commission for the purpose. Railway construction in Canada has presented many features of interest, and the new line is no exception. A large part of the eastern division lies far north of the settled districts, in country largely unexplored, so that both the location and construction work presented many difficulties. The work and difficulties are described interestingly in the present article. It gives also (among other special features) some of the instructions laid down in regard to the economic considerations of location; that is, for determining the relative values of different locations from the point of view of economic operation of the railway.

The general project of a new Canadian transcontinental railway was described at some length in ENGINEERING NEWS in 1903 and 1904, and since then we have published at different times information relating to the progress of the work. It may be explained that it is a government project, but that the government itself is building only the eastern division, from Moncton (New Brunswick) to Winnipeg (Manitoba). This work is under the direction of the Transcontinental Railway Commission. The western division, from Winnipeg to the new Pacific coast city and port of Prince Rupert, is being built by the Grand Trunk Pacific Ry. Co. (backed by the Grand Trunk Ry. Co.), and this company will operate the entire line under lease from the government. The present article deals only with the eastern division. It is compiled mainly from information furnished to us by D. MacPherson, Assistant to the Chairman of the Transcontinental Railway Commission (and formerly Assistant Chief Engineer); this included a detailed statement prepared for us, at the instance of Mr. MacPherson, by Karl Weatherbe, one of the assistant district engineers. The map, Fig. 1, is from the official map, and shows both the route of the new line and its relation to existing lines. We have plotted upon it also the approximate route of the new lines of the Canadian Northern Ry. described in ENGINEERING NEWS, Nov. 9, 1911. A condensed profile from Moncton to Winnipeg is given in Fig. 2.

GENERAL STATEMENT

In 1902 a company was formed in Quebec to build a railway from Atlantic tidewater (on the Saguenay River) to Port Simpson, on the northwest coast of British Columbia. The line was to be known as the Trans-Canada Ry. In the following winter, three parties were placed in the field, one at either end, and the third party north of Lake Winnipeg. Several hundred miles were surveyed and some knowledge of the character of the country was obtained. Early in 1903, the newly formed Grand Trunk Pacific Ry. Co. took over the scheme and the parties were recalled. A new and more southerly route was then projected, extending from Winnipeg westerly to Edmonton, and thence to some undetermined point on the Pacific Coast, and easterly from Winnipeg to a junction with the Grand Trunk Ry. at North Bay, on Lake Nipissing.

This easterly division swung north along the waters of Lac Seul and the Ogoki River as far as the 88th meridian before turning southeast. It penetrated a country little known, and uninhabited except by a few scattered families of half-starved Ojibways. A reconnaissance was made over the whole route as projected, which included a branch from Lac Seul to Fort William (on Lake Superior). Ignorance of the country, shortness of supplies, lack of transport facilities, and outbreaks of scurvy were among the difficulties with which the parties had to contend. A few caches had been established at isolated points, but, for the most part, supplies were brought in with the parties and replenished from the nearest fur-trader's outpost or Hudson's Bay Co. depot.

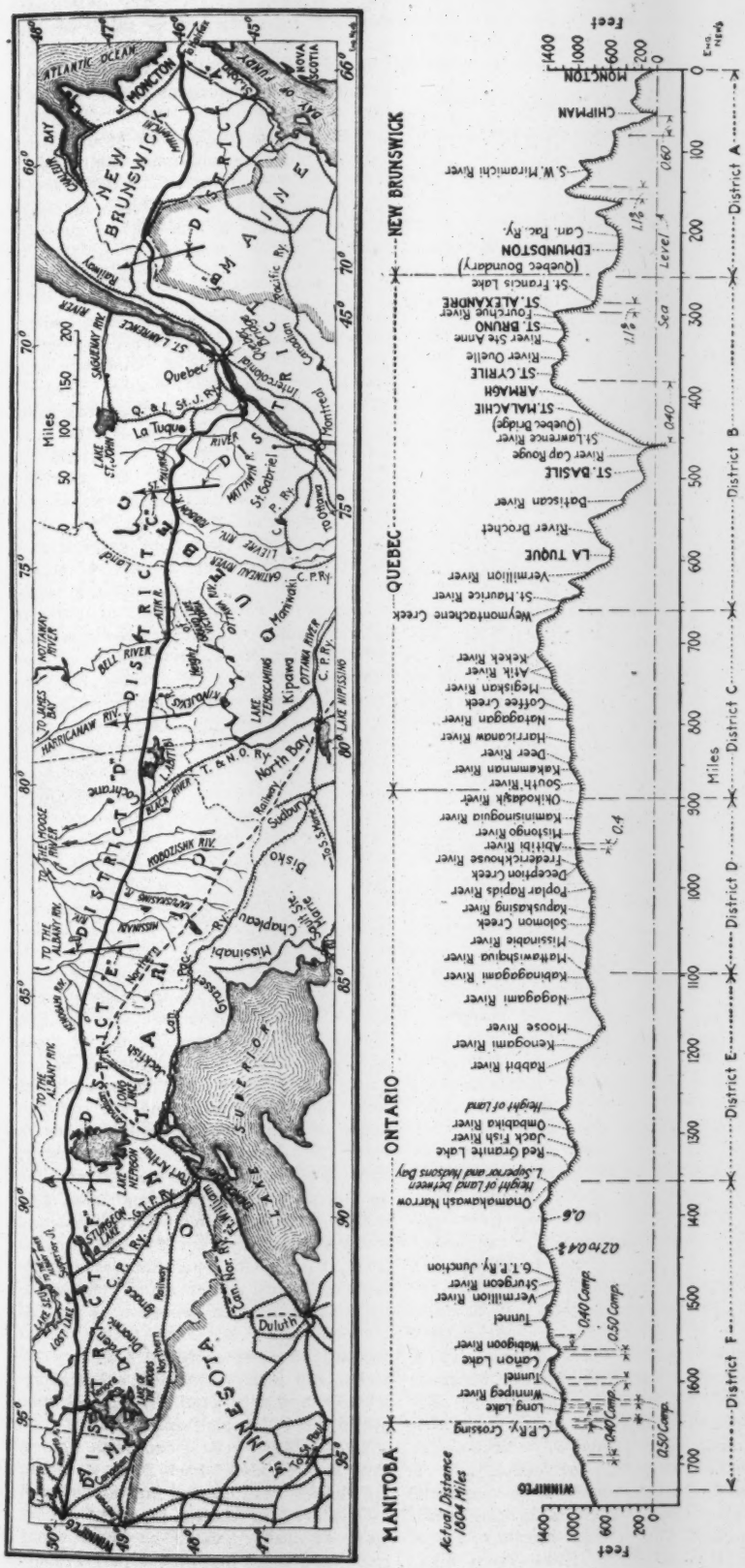
In 1904 the Dominion government appointed the National Transcontinental Railway Commission for the purpose of taking over and building the line from Winnipeg east. The Grand Trunk Pacific Ry. is building west from Winnipeg to the Pacific Coast and will operate the entire line, as noted above. Under this commission the route of the eastern division was again changed and a year was spent on new surveys and the study of those already made. It was then laid out to skirt the north shores of Lake Nepiogon and Abitibi, continuing in the same general direction to the headwaters of the St. Maurice River, crossing the latter near Quebec, and proceeding thence in as direct a line as possible (without leaving Canadian territory) to Moncton, at the southeastern corner of the province of New Brunswick. There it connects with the Intercolonial Ry., which is owned and operated by the government and which extends to the Atlantic ports of St. John and Halifax.

While contracts were let and construction was commenced at Winnipeg and Quebec as early as 1906, final location through the remote districts of northern Quebec and Ontario was not completed until late in 1908, and revisions have since been made from time to time. Before the most economical location was staked out, before even a satisfactory line could be projected, an enormous belt of country had to be explored and mapped. From Lake Nepigon eastward to the St. Lawrence valley, two main routes were selected for exploration. The one eventually adopted has been described above. The other followed a more or less direct line, passing close to the south shore of Lake Abitibi, touching the north end of Grand Lake Victoria (an expansion of the Ottawa River), and proceeding thence across the Gatineau and Lievre Rivers to the Mattawin and St. Maurice. An alternative route in New Brunswick, by the St. John River valley, was also surveyed.

The total distance from Moncton to Winnipeg was estimated to be about 1900 miles, on what was assumed to be the most direct feasible route. The problem of definitely locating this route was not an easy one, as for more than half the distance the line of general directness ran through an unsurveyed, unsettled and practically unknown region cut up in all directions with a network of lakes and rivers, many of them not shown on any existing maps, and when so indicated, often found to be entirely misplaced. The engineers had, therefore, in many cases to make their own maps as the surveys proceeded, and had in all cases to correct and complete existing maps.

SURVEY WORK AND LOCATION

During the autumn of 1904 and the following spring, some 34 survey parties were equipped and sent out, and before the end of 1905 there were 45 parties in the field, consisting of about 18 men each, not counting a large number of men engaged in transporting supplies by



FIGS. 1 AND 2. MAP AND PROFILE OF THE EASTERN DIVISION OF THE CANADIAN TRANSCONTINENTAL RAILWAY: MONCTON, N. B., TO WINNIPEG, MAN. (1804 MILES).

canoe and packing in summer and by dog train in winter. Each survey party had an engineer in charge, transitman, leveller, topographer, draftsman, rodman, picketman, two chainmen, cook and eight or nine axemen and packers. Each party was given certain governing points to connect, and was instructed to thoroughly exhaust the possibilities for the most favorable and reasonably direct line between these points. Barometric explorations and compass lines were followed by preliminary lines run with transit, and plans were plotted with 10 ft. contours on a scale of 400 ft. per in.

With those plans, and with profiles on the same scale, projected locations were made on the most favorable lines and afterward actually run on the ground and called a "first location." These plans and profiles were plotted in the field, and tracings (with reports) were sent to headquarters monthly. These reports were carefully gone over by the Chief Engineer and Assistant Chief Engineer, necessary changes suggested, and instructions issued accordingly. Whenever the head of a party completed what he considered the best possible "first location," the engineer in charge was changed and another man given a chance to improve the line by making his best attempt at a revised location. The original head of the party, or a third man, was given a chance to still further revise for a final location. In this way, it was found that a healthy rivalry was established and good results obtained. Revision of location is, however, never considered as finished until construction work is well under way, as it is often found, after the line is cleared, that slight changes will effect a very considerable saving.

An equation table giving definite values for savings in distance, curvature, rise and fall, etc., was furnished all parties in the field, so that, having the estimated cost of construction of any two or more lines, the better one to adopt from all points of view could be at once determined. This table is given further on.

The earlier explorations and reconnaissances were made by compass and barometer, followed by transit with stadia, or chain and level. Steel-band chains were used for distances in final location. The parties consisted usually of 18 men in settled districts to 24 men in unsettled districts, six of the latter number being packers. In general, they were sent into the field in pairs, at intervals of about 80 to 150 miles, with instructions to run, respectively, east and west from some more or less well defined point. In the more remote localities, it was found impossible to fix these points at all accurately, owing to the non-existence of reliable maps; nor could the course of the indicated route be followed closely owing to the presence of some unsuspected large body of water or other topographical obstruction. Consequently,

TABLE 1. VALUE FOR EQUATING DISTANCE

Class	Value per Train mile	Value per ft. per daily train per annum	Capitalized value per daily train per annum per ft.	Capitalized value per daily train per annum per mile*	Saving per daily train per annum per mile of shortening	Justifiable expenditure per mile of saving in distance per annum for 12 daily trains	Justifiable expenditure per mile of saving in distance per annum for 20 daily trains
A	0.30	2.0c.	$0.50	$2600	$104	$31,200	$52,000
B	0.50	3.4c.	0.85	4500	180	54,000	90,000
C	0.60	4.0c.	1.00	5300	212	63,600	106,000
D	1.00	7.0c.	1.75	9200	368	110,400	184,000

*Capitalized values per mile to nearest $100 and interest 4%. One daily train each way equals two daily trains.

A. Distances so short as not to affect track or train wages; aggregating less than two miles.

B. Distances affecting train wages, but not so great as to affect the number of stations or sidings. From two to five miles.

C. Distances so great as to affect number of stations and sidings required. From 5 to 75 miles.

D. Distances so great as to affect number of engine districts. Over 75 miles.

much difficulty was encountered in joining up the surveys of two approaching parties. At the head of the St. Maurice, the Tete de Bulle Indians were found to possess an unusual aptitude for cartography, and by following their rude maps, a junction was effected with the party running east from the Gatineau.

Working in a country so cut up with lake and river expansions as to be more than 50% water, absolutely unmapped and unknown, and some 250 miles from the nearest railway, two parties overlapped several miles, one being 10 miles north of the other, before communication was established between them and a connection made. A rough stadia traverse, 80 miles long, following the old Indian canoe route from Lake Abitibi to the Kenojevis River, and occupying 11 days, furnished course and distance between surveys which had started nearly 200 miles apart. In the Kenogami District, one of the earliest G. T. P. Ry. parties exhausted their provisions, and searched three days without finding a line, which had been blazed north from a supply cache, to which they tied in their reconnaissance. They left behind them as a record of their experience a string of lakes bearing the suggestive names: "Storm," "Ice," "Poverty," "Stampede" and "Relief." By discharging ship's rockets simultaneously on a prearranged night, quick connections were in several instances effected across unsurveyed gaps.

Observations for latitude were made, of course, but as there were at the outset no means of intercommunication between the parties in remote localities, other than through the district headquarters, on the Canadian Pacific Ry., months elapsed before these could be interchanged.

Values for Equating Distance, Etc., in Location

It has been noted above, under the heading of "Location" that field parties were furnished with equation tables showing definite values for savings in distance, curvature, etc. The values given below were used in the final determination of location. Tables I and II

TABLE II. VALUE FOR EQUATING RISE AND FALL (ALL TRAINS)

(Freight train velocity limits: max.; 30 m.p.h.; min., 10 m.p.h.)

Class	Value per ft. rise and fall per daily train per annum: Value	Capitalized value	Justifiable expenditure per ft. of saving in rise and fall for 12 daily trains per ann.	Justifiable expenditure per ft. of saving in rise and fall for 20 daily trains per ann.
	$	$	$	$
A. Minor grades.	0.12	3	36	60
B. Minor grades.	0.48	12	144	240
B. Ruling grades	0.88	22	264	440
C. Minor grades.	1.00	25	300	500
C. Ruling grades	1.40	35	420	700

A. All rise and fall up to 30 ft.

B. Where grades require shutting off steam but not application of brakes in descending. This class includes all rise and fall of over 30 ft. on grades less than 0.6%, and between 30 and 100 ft. on 0.6% grades and steeper grades of small drop not covered under Class C.

C. Where grades require the application of brakes and shutting off steam in descending. This class includes all rise and fall of over 100 ft. on grades of 0.6% and a proportionate fall on steeper grades.

give the values for distance and rise and fall. For calculating the justifiable expenditure per mile, 10 daily trains each way (equal to 20 daily trains) were assumed for the line between Moncton and Quebec, and also between Winnipeg and the junction with the branch to North Bay; between other points 12 daily trains were assumed. Justifiable expenditure per mile takes into consideration maintenance of rails, ties, ballast, etc.

Values for Equating Curvature (All Trains)—The elimination of 1° of curvature will save 16c. per daily train per annum (including passenger and freight trains); equal to a capitalized value of $4 per degree. Justifiable expenditure per degree of saving in curvature; $48 for 12 and $80 for 20 daily trains. If a curve is in a particularly dangerous place, which necessitates a watchman or other additional expense, the value of its elimination must be considered separately. One degree of curvature means one degree of central angle, regardless of radius of curve. It is assumed that expense due to curvature is in proportion to the total central angle.

Assumed Costs per Freight Train Mile, Engine Mile, Etc.—Train mile, $1. Engine mile, 35c., both assisting and running light; 40c. if assisting both ways, with no light running. Minimum cost for assistant engine when not at division point or used for yard work, $18 per day or $6600 per annum. Light running, 25c. per engine mile. Switching, 30c. per engine mile. Doubling grades, 90c. per engine mile straight distance, or 45c. per additional engine mile.

Values for Railway Grade Crossings — Justifiable expenditure to save one normal grade crossing of another railway, $40,000.

Transportation and Supply

Much of the early organization had to do with transport and supply problems. Through New Brunswick, Manitoba and the settled portions of Quebec existing railways, roads and steamship lines gave easy access to all parts of the line. LaTuque (at the head of navigation on the St. Maurice River), St. Gabriel, Maniwaki and Kipawa (terminals of the Canadian Pacific Ry. branch lines), and North Temiskaming, at the extreme end of the lake of that name, were the points of departure from which radiated canoe routes to the vast wilderness of northern Quebec. Between Lakes Nepigon and Abitibi, the Moose and Albany Rivers spread their finger-like branches southward to within short distances of the C. P. Ry. main line, furnishing water routes which were reached by canoe and portage from Bisco, Woman River, Chapleau, Missinabi, Grassett, Montizambert and Heron Bay. Lake Nepigon afforded comparatively easy access to a hundred-mile stretch across its northern drainage area; while to the west, Ignace, Dinorwic, Dryden and Kenora were used as shipping points to Sturgeon and Minnitaki Lakes, and the Wabigoon and Winnipeg Rivers.

In the autumn of 1904 and winter of 1905, from 40 to 50 completely equipped parties were placed in the field between Moncton and Winnipeg. Some of these hardly reached their destination before being overtaken by the "freeze-up," and were forced to return and cut trails in order to bring up sufficient supplies to carry them over the winter. A transport department was organized, and as soon as the condition of roads and lakes permitted, large quantities of provisions and outfit were pushed north to the furthest limit of lumbering operations over existing bush roads, and stored in main transport depots, or in warehouses of the Hudson's Bay Co. From these, part of the supplies were forwarded by dog sleigh and packer, and the balance distributed by canoe after the ice had gone out in the following June.

Caches were established from time to time at intervals of from 20 to 40 miles; log shacks were erected and a couple of men placed in charge of each. These were generally located on some canoe route, and being maintained permanently, as long as the surveys lasted, consti-

tuted an important aid in their prosecution. Regular systems of mail service were provided later, following the supply routes, but during the long freeze-up lasting from about the middle of October to the middle of December, and to a less extent throughout the break-up, extending over the greater part of April and May, insecurity of ice on river and lake practically put a stop to communication with the outside world. Throughout most of Quebec and western Ontario, innumerable waterways, many of them rendered navigable for canoes by beavers, provided an easy method of moving camp. But across the interminable muskegs and spruce-covered swamps of the clay belt, parties had in summer to depend solely on the tump line to pack their supplies and outfit.

Medical officers were stationed at wide intervals, but there was little sickness

FIG. 3. A "COYOTE" BLAST; GRADING WITH EXPLOSIVES ON THE CANADIAN TRANSCONTINENTAL RAILWAY

that could not be cured by a blue pill. The most serious discomforts endured were black flies in summer, and a few intensely cold days in midwinter when the mercury sometimes touched 60° below zero. Accidents due to upsetting canoes and breaking through ice were unfortunately too common. In the first three years of the survey 27 lives were claimed by the frigid waters of river and lake, at that time the only highways. Narrow escapes were of almost daily occurrence. On several occasions, parties were caught by the freeze-up on their way out, canoes being abandoned, and treacherous river crossings negotiated on hands and knees. Two men tried to run a 30-ft. chute on the Gatineau. One jumped onto a rock, and the other was rescued with difficulty from the pool below after the canoe had been dashed to pieces. Another canoe broke in half while descending the Woodchuck rapids on Bell River, and the occupants paddled five miles into camp seated one in either piece.

GRADES AND ALIGNMENT

At the outset it was decided that the railway should conform to a high standard. Grades were not to exceed 0.4% opposed to eastbound traffic (which is the heavier), nor 0.6% against westbound traffic. The curvature was limited to 6°, and all curves of 1° and over were connected to their tangents with easy spirals. The 6° limit for curves was used only where topographical conditions prevented easier curves being used at reasonable cost. Grades were compensated for curvature at the rate of 0.40% per degree, so that on 6° curves the maximum grade (eastbound) was 0.16%. Vertical curves were introduced at summits and sags, the rate of change in grade being 0.1% and 0.05%, respectively.

Pusher grades were adopted at two points only and are quite short. The whole line between Moncton and Winnipeg (with the slight exception of short approaches to the Quebec Bridge on 1% grades) was definitely located with the above mentioned very easy maximum grades. But 146 miles from Moncton, it was found that by the insertion of about 12½ miles of 1.1% grade adverse to eastbound traffic, a saving could be made of 17.2 miles in distance, nearly $2,000,000 in construction and $1,250,000 in capitalized operating value. At another point (in Quebec) 286 miles from Moncton, a similar grade 10 miles long, adverse to eastbound traffic, was found to effect a saving of 18.8 miles in distance, about $500,000 in construction, and over $750,000 in capitalized operating value. These possibly temporary grades were adopted with the corresponding saving in distance and cost. If the future traffic of the road justifies the expense, these two short links of standard grade can be built at any time.

In comparing rival routes, values based on assumed capitalized cost of maintenance and operation were given to savings in distance, curvature, and rise and fall as noted above. Owing to the locality traversed, artificial values for these, due to competition, seldom had to be considered. Distance was evaluated at $6 to $35 per ft., depending on amount saved and expected traffic; curvature at $48 to $80 (or more) per degree; and rise and fall at $36 to $700 per ft. on long maximum grades requiring the application of brakes in descending.

Throughout the 1800 miles between Moncton and Winnipeg the geographical characteristics, and consequently the engineering problems, varied greatly. The short route across the broken topography of New Brunswick necessitated long stretches of maximum grade and development for distance, culminating on the slopes of the divide between the Mirimachi and St. John Rivers. Even with a short pusher grade of 1.1% eventually adopted here, cost of construction was very heavy. This included a tunnel and 3918 ft. of viaduct, 193 ft. high, over the Little Salmon River. A pusher grade was also required to negotiate the summit between the St. Lawrence and Bay of Fundy waters, near the extreme northern corner of Maine.* In southern Quebec, the line parallels the St. Lawrence, 20 miles inland, before swinging north to where the substructure for the new Quebec Bridge is rapidly nearing completion. Just beyond, another great viaduct, 3000 ft. long and over 160 ft. high, was required to span the gulch of Cap Rouge. Three of the piers for this were sunk by pneumatic caisson, one to a depth of 55 ft. below high water.

LOCATION AND ROUTE NORTH OF THE ST. LAWRENCE

Perhaps the most difficult problem confronting the locating engineers, on the whole eastern division, was to find a path through the forbidding range of hills loosely called the Laurentian Mountains, which forms the northern watershed of the St. Lawrence River. Some 80 miles west of the city of Quebec this range is abruptly cleft, enabling the St. Maurice River to carry south the accumulated drainage of 15,000 sq.miles. Three alternatives were proposed: 1, to develop a line up one of the more easterly streams until sufficient altitude should be attained to cross over into the St. Maurice valley

*See the profile (Fig. 3) in "Engineering News," Dec. 21, 1911.

and follow this to its upper waters; 2, to enter this valley at its lower end, cross it, and attempt to reach the hinterland by way of the Mattawin or Riviere aux Rats, two of its main tributaries from the west; or 3, to proceed further up the St. Lawrence, and pierce the Laurentian at some more westerly point, avoiding the precipitous cliffs of the St. Maurice.

All of these routes were explored. The third, apart from other objections, proved too long. The second and most direct was reported against on account of the excessive slope in the lower waters of the valleys explored, the difficulty of developing distance within their narrow confines, and the great cost of bridging the lower St. Maurice. The approved route followed up the rivers Batiscan and Brochet, until a pass was reached overlooking the hamlet of La Tuque, at the head of navigation on the St. Maurice where the latter turns from southeast to south. The descent was effected by fitting a two-mile horseshoe curve into a recession of the hillside.

Beyond La Tuque, the waters of the St. Maurice come down 80 miles from the old Hudson's Bay post at Weymontachene, dropping 700 ft. in a series of cataracts and turbulent rapids. Its course is fairly direct, except for a long detour to the north around the 16 miles of air line between the mouth of the Vermillion and CooCoo Cache. Four miles above La Tuque, the main river is bridged by six 140-ft. trusses, on concrete piers, and the precipitous side-hill is followed to the Vermillion. Here, after repeated efforts, a circuitous route through the long granite ridge was located in CooCoo Cache, and the St. Maurice again followed to Weymontachene.

From Weymontachene to the Gatineau River, the obvious route appeared to be via the Ribbon River, but a 10-mile saving in distance was effected across from its mouth to its upper basin. However, this involved two semi-loops, a 100,000-yd. summit cut and several others of slightly less magnitude. The first preliminary west of the Ribbon struck far to the north, via Haircutting Lake, avoiding the Gatineau valley altogether. Later the east branch of this was crossed and the sinuous line between interlacing waters of the St. Maurice and Gatineau roughly followed to where it intersects the "Height of Land," 50 miles beyond.

Innumerable lakes and creek expansions, separated by irregular ridges of sand and boulders, covered with jack-pine, here constitute the outstanding features of the topography. So intricately interwoven are these, that the country had to be criss-crossed with lines for a width of 20 miles before a satisfactory alignment could be obtained, with a profile showing only moderately heavy work. Similar conditions prevailed for a further distance of 25 miles to the Atik River, which was followed to its junction with the Megiskan, a branch of the great Nottaway. This region was the most inaccessible and least known on the whole line, and will be the last to be completed.

While the St. Maurice valley was being explored from the Quebec end, engineers sent north from Ottawa, North Bay and western points, had made the unexpected discovery that the country beyond the "Height of Land" presented far fewer difficulties than that draining into the St. Lawrence. Accordingly, late in 1905 the route south of Lake Abitibi was abandoned.

The actual "Height of Land" is crossed three times in northern Quebec, and twice in northern Ontario, with elevations above mean tidewater of 1500, 1070, 1075, 1120 and 1260, respectively. At all of these points except the most westerly,

FIG. 4. COFFER-DAM FOR THE MAIN PIER OF THE ABITIBI RIVER BRIDGE

the work is light. From the Megiskan River to Lake Nepigon, occurs a vast spruce-covered plain, of which the soil is a deep agricultural clay, interspersed with a few sand ridges and isolated outcrops of rock, and covered in many places by from 1 to 10 ft. of muskeg. That part east of Lake Abitibi (a shallow and muddy expansion of the Abitibi River, 400 sq.miles in extent) is intersected by the sluggish waters at the sources of the Nottaway and Harricanaw Rivers. The western portion, on the other hand, is drained by swift flowing branches of the Moose and Albany Rivers, so numerous as to require a bridge on an average every sixth mile, not counting arch culverts up to 30 ft. span. These show on the profile as deep gulches, separated (except for an occasional long shallow cut) by mile after mile of surface line within a few feet of subgrade.

The alignment throughout this section is exceptionally direct. For 250 miles westerly from Lake Abitibi, the length of preliminary location exceeded the air line by less than 4%; it contained only six curves of 3° and none over 3°. The first G. T. P. Ry. reconnaissance, run in 1903, between the Kenogami and Missinabi Rivers, was a straight line 115 miles long. On final location some of the very long tangents were broken up to obtain more favorable river crossings, but several stretches of 16 to 18 miles were retained.

North of Lake Nepigon, granite ridges alternate with flat stretches of muskeg and clay. These latter occur with decreasing frequency as the line crosses the "Height of Land" for the last time to enter the rock-ribbed and unproductive wilderness which forms the barrier separating the farm lands of eastern Canada from the prairies. With the exception of a short tract of indifferent agricultural soil, between Lost Lake and the Wabigoon River, the country is barren and desolate, much of it having been denuded even of its original growth of stunted spruce.

An enormous number of irregular bodies of water lie scattered over its surface, many of them with shores deeply indented, and buttressed by rugged cliffs. In the vicinity of Onamakawash Lake, along Canyon Lake, and on both sides of the Winnipeg River, the rock cuts were exceptionally heavy. Embankments of even larger size had also to be made of rock borrow and train-hauled material. Corresponding conditions prevail along the line of the Canadian Pacific Ry., and repeated surveys showed that no improvement could be effected by adopting a still more northerly route. The last 50 miles into Winnipeg is, for the most part, through settled prairie country. By crossing and keeping south of the C. P. Ry., the worst portion of the deep Julius muskeg, which required years to fill, was avoided.

CONSTRUCTION WORK

Actual construction began in the spring of 1906, contracts having been signed for the building of 150 miles from Quebec west, and 245 miles from Winnipeg east. The latter portion was to a connection with the branch to Fort William (then under construction by the Grand Trunk Pacific Ry.), thus giving a line from the wheat district to Lake Superior. From time to time additional sections were let, until by October, 1908, the whole line was under contract. Supplies for constructing the most easterly 850 miles were distributed from various points on the Intercolonial, Canadian Northern and other railways. The extreme western end was also easily accessible by steamer and short winter road from various points

on the Canadian Pacific Ry. as far east as Dinorwic. The central portion was opened up east and west from La Tuque, the Temiskaming & Northern Ontario Ry., Lake Nepigon, and the Thunder Bay branch of the Grand Trunk Pacific Ry.

Steel on the Quebec & Lake St. John branch was laid into La Tuque early in 1907. About the same time the T. & N. O. Ry. ran its first train into McDougall's Chutes at the head of navigation on the Black River, a tributary of the Abitibi. From here, two main transport routes were established. One extended upstream into Abitibi Lake. The other followed down the Black and Abitibi Rivers, to where the new line crossed the latter, beyond which a monorail tramway was constructed 8 miles across country to the Frederickhouse River. The tramway was operated by a platform truck having shafts attached to a pole at right angles to the rail. The horse thus walked alongside the car and rail, the car being guided on the rail by double-flanged wheels. A service of steamers and gasoline boats was established on each route, short stretches of light-rail tramway being built around the worst rapids. Push roads were also cut to provide winter communication. Later, when the T. & N. O. Ry. had extended its line 40 miles to a junction with the Transcontinental Ry. (where the town of Cochrane now stands), and steel was laid east and west over the new grade, these routes were abandoned.

Meanwhile the Grand Trunk Pacific Ry. had finished its branch from Fort William to Sioux Lookout, with a spur into Sturgeon Lake. This extended the field of operations, and gave impetus to that part required to connect Winnipeg with the Great Lakes. In the summer of 1908, a narrow-gage railway, 18 miles long, was constructed around the rapids of the Nepigon River, and before navigation closed that year, a considerable quantity of supplies had been distributed along the north shore of Lake Nepigon by steamers built for the purpose. In the following year an attempt was made to establish a similar transport route from Jackfish over the "Height of Land," into Long Lake, and thence down the Kenogami River. This failed, owing to the inability to secure reasonable grades up the steep ascent from Lake Superior, except at prohibitive cost.

It was accordingly decided that the 350 miles between Cochrane and Lake Nepigon should be covered from either end. By December, 1910, 40 miles at the west end of this was graded and track laid for over 100 miles at the Cochrane end. Two months later a winter tote road was completed across the remaining distance, and sufficient supplies and outfit to grade all but a few cuts were distributed in log warehouses erected at intervals of about 20 miles.

Grading

As most of the work was of the lightest description, chiefly side casting, the construction plant consisted almost entirely of shovels and wheelbarrows, with a few tons of light rails, some car wheels, and a load or two of explosives for loosening frozen clay, and breaking up boulders. This light work was practically finished by October, 1911, and up to the end of February, 1912, 20% of the balance of the excavation had been completed.

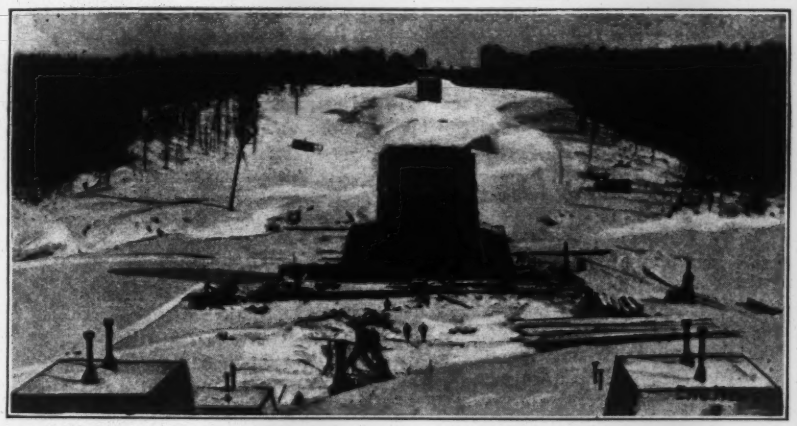


Fig. 5. Main Pier of the Abitibi River Bridge (Built in Midwinter)

In the heavy rock districts work, of course, proceeded much more slowly. The usual methods of blasting were employed: 1, block holing, loading with dynamite and firing with time fuse, in the smaller cuts; 2, heavy springing, loading partly with black powder and discharging with battery in the larger cuts, or where it was desired to break up and waste several thousand cubic yards at once; 3, tunnel blasting, or "coyoting." For this latter work, the station man was usually paid per lineal foot for shafts and tunnels. In loading these, the high explosives were sometimes left in the case, but the blast was usually more effective if the cartridges were removed from the boxes. Frequently 6000 cu.yd. or more of rock were broken up by one of these blasts. A "coyote" shot is shown in Fig. 3, on work in the Onamakaywash region. Where the expense of bringing in cars and track was excessive, the shattered rock or "muck" was removed by stone boat on pole track, the poles being well iced in winter, or lubricated with black oil in summer.

Deep clay cuts in the Abitibi region were excavated with less expense in winter, as in summer horses could only travel in the greasy blue gumbo after the cuts (and often the fills as well) had been corduroyed. But in the winter, so long as the work progressed steadily, even in the coldest weather, the cut did not get time to freeze deeply in a single night, and the frozen top could be undermined or broken down with a few sticks of dynamite. A slight additional expense was incurred in winter by shovelling snow away from the base of the dump.

Much of the grading in New Brunswick and Quebec was performed with steam shovels having dippers of ½ yd. to 2½ yd. capacity. These were hauled into the work in winter with their necessary complement of dinky engines, cars and track. Some of the smaller machines were similarly used in northern Ontario. Scrapers, both wheel and slush, were employed on the prairie section, and elsewhere generally for light sandy work, a few being sent in across Lake Nepigon. An elevating grader was tried in the Abitibi country, but was soon discarded, as the horses mired in the sticky clay.

Slides

Slides were numerous throughout the clay belt. These occurred, to some extent, in the sides of cuts, which frequently required a slope of 1 on 2 or even flatter. Much more serious, however, were those which took place under deep fills and behind concrete abutments. At Brule Creek and the Okikodasik and South Rivers, heavy concrete structures on piles were moved bodily out of place, but the shifting from original position was not sufficient to prevent the erection of the steel superstructure after movement had stopped. In some instances it appeared probable that pressure behind the concrete had deflected the piles laterally through the yielding clay; in others, that the slip had occurred on an inclined plane below the level of the foundations.

At the little Mistongo, a long 6-ft. concrete arch was built on pile foundation, and the deep gully bridged by a light trestle, from which material excavated in an adjoining cut was dumped. Some of this, in wet weather, simply flowed away in a river of mud. After several slides had occurred, which broke up and buried the culvert, sweeping three or four

trestles in succession down the slope, the fill was completed in winter, a large square box culvert of heavy timber being built to replace the arch culvert. With the freshet, the embankment again set-

FIG. 6. TEMPORARY TRESTLE AND PERMANENT PIERS FOR STEEL BRIDGE OVER THE FREDERICKHOUSE RIVER

tled, and a small lake formed on the upstream side, from the middle of which protruded one end of the timber culvert, standing upright. Continuous filling at length brought the embankment up to grade, the water being at first pumped and siphoned over the top, and later carried off through a reinforced-concrete pipe built permanently through the bank and having a long extension at the downstream end.

BRIDGES AND CULVERTS

On completion of the main surveys, small parties were sent over the line with instructions to take soundings where any openings were to be left. A light boring machine was used, by which casing pipe screwed together in sections was forced down through the river bed, and the core broken up with the drill, and removed by means of a rope attached to a short tube with ball valve. At the Manuan River, this machine was set on the ice, and the casing driven by an improvised pile driver, consisting of a section of green birch for hammer, working between leads and operated by transport dogs. When the ice went out the machine was transferred to a raft, and the dogs harnessed to the spokes of a windlass. By this contrivance, pipes were driven through 50 ft. of hard compacted sand.

The treacherous soil of the clay belt was the cause of a great deal of trouble in securing stable foundations, especially when attempting to excavate in midstream. A coffer-dam for the main pier of the Abitibi Bridge, consisting of 4 ft. of puddle, between an outer row of 12-in. ordinary sheet piling, and an inner row of Wakefield sheet piling, 18 in. wide, failed to prove watertight. Eventually a continuous lining of steel-sheet piles was driven around the inside and left in the work. The coffer-dam was then partly unwatered, and material squeezed up by the foundation piles excavated with an orange-peel bucket to slightly below the river bed. Concrete for this pier was laid in mid-winter, much of it under water, being prevented from freezing by the injection of steam. Figs. 4 and 5 show work at this pier. A coffer-dam of sand bags at the Mattagama was used, with indifferent success.

When possible, long spans were used to avoid foundations in midstream where clay was encountered in the river bed. For shore foundation pits, round logs were generally used to prevent caving in, as sawn lumber was expensive or unprocurable where such pits were dug ahead of the steel. Trestles of unsquared timber were erected at most of the openings where a bridge or culvert was required. They were constructed of the largest timber in the vicinity, irrespective of variety, even cottonwood being used. For the longer stringers, however, British Columbia fir was imported. These trestles were of the most temporary character and in a few cases failed to withstand the impact of outgoing ice during the spring freshets. They served, however, to get the track ahead, so that steel and cement could be brought in for the permanent structures. Fig. 6 shows the temporary trestle and the piers for the permanent bridge at the Frederickhouse River.

Concrete was almost universally employed for substructures. This was partly owing to the absence of good quarrying stone, but more largely to the scarcity of skilled stone cutters and masons.

There will be about 240 steel bridges and viaducts, or a total length of 11 miles, and aggregating 61,000 tons. Of this amount, 52,000 tons have been erected or are under construction, leaving about 9000 tons to be let. The greater part of this will be erected in 1912 and the balance in 1913. The maximum single span is 300 ft., and the Winnipeg River bridge, Fig. 7, is an example of these 300-ft. truss spans. Steel viaducts are built with 40-ft. towers and 60-ft. intermediate spans. The viaduct over the Mistongo River (Abitibi region), shown in Fig. 8, is typical of these structures. All bridges are designed according to Dominion government specifications; engine loading, class "heavy," weight 180 tons, 49,400 lb. on each pair of drivers. Plate girder spans, both through and deck, are used up to a length of 100 ft. Bridge lettings are generally given early in the year and cover the required erection for the same year, depending on the concrete being completed and track reaching the bridge site. Upon these conditions the time of completion depends. For transportation, construction rates are given bridge companies over lines under construction, on a ton-mile basis. Bridge companies are furnished with drawings and weights of steel, so all can bid under the same conditions. All steel contracts are for a pound price erected, and a unit price for timber in floor.

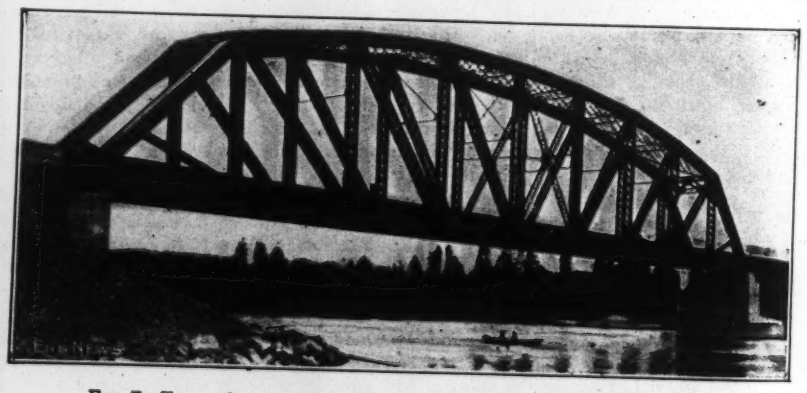


FIG. 7. TRUSS SPAN OF THE WINNIPEG RIVER BRIDGE; 300 FT. LONG

FIG. 8. STEEL VIADUCT OVER THE MISTONGO RIVER (ABITIBI REGION): CANADIAN TRANSCONTINENTAL RAILWAY

TRACK AND TRACKLAYING

The track is laid with 80-lb. rails of Am. Soc. C. E. section, 33 ft. long, with four-bolt angle-bar joints. There are 3000 ties per mile, 18 ties per rail on tangents and 20 on curves. By far the greater part of the ties cut for the line are of jack-pine; tamarack, hemlock, cedar and spruce are used in lesser quantities. Both single and double boom "pioneer cars" were used in tracklaying work. Tracklaying was sometimes carried on throughout the winter, the snow being in some cases shoveled or ploughed off the grade, or simply tramped down sufficiently not to impede the "tie buckers." Finally snow packed about the ties was found to make a much firmer and more even skeleton track than that laid in summer, but when this melted, a lot of repairing and shimming was required to render the line safe for material and surfacing trains.

Throughout January, 1912, tracklaying was continued west of the Nagagami River at the rate of one-third mile per day, with the thermometer often 40° below zero, and seldom above 5° below. Under favorable conditions, two miles of track a day was often laid for short periods, but temporary interruptions usually brought the average down below one mile a day.

TELEGRAPH

The telegraph line is being built at the same time as the railway. It provides for an ultimate capacity of 12 wires, although only two wires are now being erected.

PROGRESS AND DELAYS

It was hoped the entire railway would be completed in six years. Progress, however, on that portion to which access could be had only from either end, was continually interrupted by delay in getting out some large cut, failure of a temporary structure, development of sink holes, or other unforeseen cause. Throughout part of northern Ontario and Quebec, no supplies could be moved except in winter, by reason of the extensive prevalence of clay and muskeg, over which horses could not travel. In other localities, such as those served by Lakes Nepigon, Sturgeon and (to a less extent) Abitibi, contractors were dependent for transport on the season of open navigation. Frequently it was essential to have supplies conveyed part way by steamer and part by winter road.

Failure to foresee and make provision for what should be required months, or even a year ahead, meant serious loss. Uncertainty regarding the duration of the seasons had to be allowed for also. In 1907 there was a 2-ft. depth of snow in the Kenogami district on June 1, and the ice in Lake Nepigon did not break up until June 16; whereas on another occasion snow had disappeared from long stretches of the tote roads (running east from Cochrane and Matheson) before the end of March. Navigation could not generally be relied on after about Oct. 20 on many of the waterways traversed. Toward the close of one of the busiest seasons on Lake Nepigon, both steamers operating on this route went aground within a fortnight of each other, in consequence of which large quantities of essential supplies were not delivered until late in the winter. During the excessively dry summers of 1909 and 1910, disastrous forest fires swept over the country. These did enormous damage along the line north of the "Height of Land," burning up contractors' camps, warehouses and plant, and putting a stop to the work in many localities.

Scarcity of labor, and time lost in replacing men who quit, was an ever-present cause of delay. By far the greater part of the grading was sublet to "station men," who frequently "jumped" if they found themselves going behind with their work. Prices, however, were high, and in most cases covered the extra cost of pushing the work in the face of unfavorable conditions.

The undertaking has now progressed to such a point that it is reasonably certain trains will be running across the whole eastern division sometime in 1914. The track is already laid 355 miles eastward from Winnipeg and 750 miles westward from Moncton, except for a short distance in southern Quebec, and the yet unbridged St. Lawrence.

Another stretch of track extends east and west of Cochrane, covering 330 miles of the clay belt. This leaves a gap of 150 miles in northern Quebec and another of 240 miles in northern Ontario. Across the former, contractors were putting in supplies last winter, but except for the most easterly 10 miles, which is partly constructed, no grading has yet been done. Throughout the latter, however, only a small amount of excavation and some temporary trestles remain to be completed, on which work is being rushed, so as not to delay the "pioneers" of the tracklaying gangs working from either end. These are expected to meet not later than the end of the present year, giving through connection by way of the T. & N. O. Ry. between the cities of eastern Canada and the wheat fields of the West.

Across New Brunswick, east and west of the city of Quebec, for about 100 miles out of Cochrane, and between Winnipeg and Superior Junction, train-

THE COMMISSIONERS OF THE TRANSCONTINENTAL RAILWAY

Contract No..... District..... Contractor.....

Percentage Report of Work Done, Month Ending.....191....

Division No .... from Mile.....to Mile.....

Class of work	Percentage done in month	Percentage done to date	Cost of work done during month	Cost of work done to date	Approximate estimate of total cost of work	Brief description of work done
Grading.....						
Tracklaying.....						

FIG. 9. HEADINGS OF MONTHLY PROGRESS REPORT

filling, surfacing and ballasting are finished; steel bridges are in place; water tanks, stations and section houses built, or under construction; telegraph line strung, and the line practically ready for operation. Division yards are located at an average of 120 miles apart, and the grading and the work on engine houses and other necessary structures for these are well advanced, at all except three of the yards. Sidings are provided about seven miles apart, with a water tank at every third siding.

While the whole country west of the settled part of Quebec was a wilderness six years ago, thriving towns have since grown up at LaTuque, Cochrane, Hearst and Graham. All of these are actual or prospective junction points with other railways, and all in the midst of vast pulp-producing forests. La Tuque has the enormous undeveloped water powers of the St. Maurice River behind it, and Cochrane and Hearst are destined to be the market towns for the future farms of the clay belt.

Progress Reports on Construction

In order to keep check on the rate of progress of the work, Mr. MacPherson introduced percentage forms of reports, being modifications and extensions of somewhat similar forms in use on the Canadian Pacific Ry. The form shown in Fig. 9 is returned monthly (to the Assistant to the Chairman) by the division engineers, through the district engineers, and it is then graphically plotted on a diagram, a portion of which is shown in Fig. 10. This shows not only the percentage done during the month on grading, ballasting, and all the other items of construction, but also shows the percentage done to date under each of these headings and the percentage done of the whole work in each main contract. This form of report has been found invaluable as an aid in answering requests for information from the government and for compiling the annual reports.

The form of progress report on construction is a sheet 14 in. wide and 17 in. high, divided into seven vertical columns, with headings as follows: 1, class of work; 2, percentage done in month; 3, percentage done to date; 4, cost of work done during month; 5, cost of work done to date; 6, approximate estimate of total cost of work; 7, brief description of work done. The itemized classes of work in the first column are as follows: 1, grading; 2, tracklaying; 3, ballasting; 4, trestles, culverts and small waterways; 5, permanent bridge substructures; 6, tunnels; 7, fencing; 8, water service; 9, telegraph line; 10, sundry; 11, important individual pieces of work included in the above items, but for which detail percentages are desirable; 12, engine houses; 13, buildings (stations, section houses, tool houses, trainmen's houses, freight sheds, store houses, ice houses, coaling plants, cinder hoists); 14, advances and deductions; 15, extra work orders.

The percentages are of the total amount of work done on the division (including individual works shown in detail, if any), and they represent the percentage of money value of work done. For tracklaying, ballasting, fencing and telegraph line, the percentage columns must be filled in on this basis, and also the total number of miles completed must be given in the last column (brief description).

The engineering organization consists of a Chief Engineer (G. Grant), Assistant Chief Engineer, Bridge Engineer (R. F. Uniacke), District Engineers (each in charge of a district 250 to 400 miles long), Division Engineers (in charge of 40 to 50 miles), Resident Engineers (in charge of 10 to 15 miles). The chairman of the National Transcontinental Railway Commission is R. W. Leonard.

Freight Transportation Facilities and Advantages

The originally estimated distance of 1900 miles between Moncton and Winnipeg has been reduced gradually by repeated revisions of location at various points to a distance of 1804.8 miles. This distance is 261 miles less than the shortest distance over any other combined railways between Moncton and Winnipeg. The distance between Winnipeg and Quebec will be 1351 miles, which is 223 miles shorter than the Canadian Pacific Ry., and the grades are so much more favorable that engines of equal capacity should haul nearly twice the load on the new line that they can on the latter.

Mr. MacPherson points out that transportation of grain by water has always been much cheaper than by rail, but the latter has been slowly and surely cheapening until the present time, when the easy gradients and tremendously powerful locomotives of modern lines will make a combination on land difficult to excel (or peradventure to equal) on water. The distance from Winnipeg to Quebec via C. P. Ry. to Fort William, and lake, canal and St. Lawrence River to Quebec is 1771 miles, involving five transhipments of wheat. The distance on the Transcontinental Ry. will be 1351 miles, and, as the maximum eastbound grade is 0.04%, compensated for curvature, a Mallet articulated compound is capable of hauling, on this grade, a gross

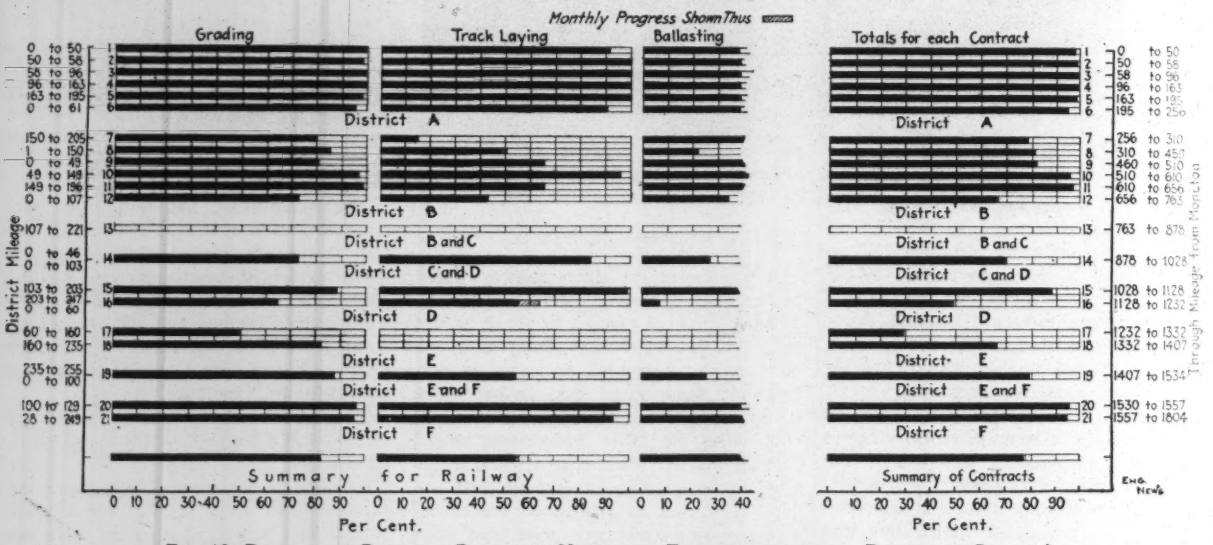


FIG. 10. PORTION OF PROGRESS DIAGRAM: NATIONAL TRANSCONTINENTAL RAILWAY (CANADA)

(The cut shows only the first three and the last of the several classes of work on the entire diagram.)

load behind the tender of 4290 tons.* Assuming the tare 33⅓% of gross load, the net paying load would be 2860 tons, equal to 95,333 bu. of wheat, in one train. Assuming the earnings of such trains to be $4.40 per train mile, or exactly double the earnings of the Canadian Pacific Ry. freight train miles for 1908, the cost per bushel over the 1351 miles betwen Winnipeg and Quebec is found to be 4.25c. The lowest rate that has been in force from Fort William to Montreal, via the lake, canal and St. Lawrence River, a distance of 1216 miles, is believed to have been 4c. per bu. in 1908. This rate for 1216 miles would be equivalent to 4.44c. for 1351 miles, so that, at $4.40 per train mile, the engines above referred to could haul grain on the Transcontinental Ry. eastbound from Winnipeg to Quebec for 0.19c. per bu. cheaper than the cheapest existing water route could haul it the same distance, and 10.86c. per bu. cheaper than the present combined rail and water rates between the two points in question; in brief, at about 25% of the present rail and water rate. It would appear, therefore, that the days of the absolute supremacy of water transportation are in danger of at least a partial eclipse.

The Improvement of the Neponset River in Massachusetts†

The Massachusetts State Board of Health in 1911 was directed and authorized by the legislature to expend the sum of $150,000 in the improvement of the Neponset River, a stream rising in the town of Foxboro and flowing into Dorchester Bay and through the towns of Walpole, Norwood, Sharon, Canton, Dedham, Milton, and the Hyde Park, Mattapan, and Dorchester sections of the city of Boston. This expenditure is to be made over a period of three years and does not include any allowance for land damages or rights-of-way, for which purposes an additional sum of $5000 was appropriated.

The primary object of the improvement is the remedying of certain unsanitary and unhealthful conditions which have long existed by reason of the flooding of about 4000 acres of land in the towns of Norwood, Sharon, Canton, Dedham, Milton, and the Hyde Park section of Boston during extended periods of each year, and the resulting existence of large areas of stagnant water. There will naturally follow an appreciable increase in the value of these meadow lands by reclaiming them for cultivation and development.

A large part of the unsanitary conditions now existing in the Neponset River is due to the discharge into the river of many different classes of paper mill, tannery, and other trade wastes, which have not only polluted the river for many years, but by the exposure of deposited wastes on the sides and bottom of the channel during periods of low flow, have given rise to very objectionable odors. The malarial conditions are undoubtedly due to the many shallow areas of stagnant water which furnish breeding places for mosquitoes.

The valley of the Neponset River has three times before been the subject of extended examination and reports by State authorities—first by the State Board of Health in 1875, later by the Massachusetts Drainage Commission in 1885 and last by the State Board of Health in its special report printed in 1897. In addition to these examinations, statistics relating to the pollution of the river and the quality of its waters were incorporated in the 1890 report of the State Board of Health.

Previous to the legislation of 1911, acts were passed authorizing the State Board of Health to take action necessary to prevent the entrance into the Neponset River of sewage and manufacturing wastes unless satisfactorily purified before their discharge into the stream. Since that time the discharge of sewage directly into the river has been entirely prevented and most of the mills, tanneries and factories discharging their wastes into the stream have been required to install disposal plants; it is intended that, by the time the improvement of the river has been completed, no pollution will enter the stream from any of these sources.

The work contemplated under the act of 1911 involves the rectification and deepening of the main channel of Neponset River from a point near the dam at the Mattapan Paper Mills to a point below Pleasant St., Norwood, a total distance by the present river of about 12.9 miles. The elimination of many of the worst bends in the river is planned so that the final length of the new main channel will be reduced to about 10.3 miles.

About 2.5 miles above the Mattapan Paper Mills dam, is the historic Pauls Bridge, crossing the river near the base of big Blue Hill. It is above this point that the meadows begin, stretching to the southwest into the towns of Dedham, Canton, Norwood, and Sharon, and the principal work on the river will be done in this section through which it is planned to excavate the channel to uniform bottom widths and slopes, changing at those points where there are important additions to the area of the contributing watershed. Cutoffs across the meadows will be made where they are necessary to secure the hydraulic head required or where they will better satisfy the requirements for drainage of the adjacent meadow areas. Below Pauls Bridge the river passes through the thickly settled portion of the Hyde Park section of Boston and through this division of the river the channel will be excavated only where necessary to give the maximum capacity provided for by the plans. This maximum capacity of the new channel will be sufficient at any point to discharge the average maximum run-off of the contributing watershed, although it will still be expected that extreme freshet flows, which have occurred at intervals in the past, will in the future somewhat flood the meadows on the Neponset River. To entirely prevent flooding during such freshet flows would involve a cost for excavation alone that would be prohibitive under the Act of 1911 and probably inadvisable and not justified.

The channels of tributary streams, including Mother Brook, Ponkapoag Brook, Purgatory Brook, Canton River and Traphole Brook, will be excavated where necessary to adjust their present channels to the new river channel.

The surveys made during the past winter in preparation for the work of construction have been very complete and were greatly aided by the unusually long continued presence of ice and frozen ground over the river and meadows. This work covered over 71,000 ft. of staked reference base lines and 750 cross-section soundings for mud depth and hard bottom on the river and meadows which covered a total length of over 290,000 ft.

In addition to the above, two secondary profiles were run and over 900 acres of the meadows were cross-sectioned and sounded for depth of mud. Current-meter stations were located at critical points and measurements frequently taken to establish rating curves. River gages at important points were established and have been read twice each day since the work began. Many samples of mud have been analyzed, these samples being collected at different depths of the mud deposit scattered over the entire length of the river.

The actual work of construction is expected to start as soon as the flood conditions on the meadows will allow; this work will involve the removal of (1) approximately 180,000 cu.yd. of mud and soft material, and (2) approximately 150,000 cu.yd. of gravel and hard material, a total earth excavation of about 330,000 cu.yd. In addition to this, (3) about 1000 cu.yd. of ledge rock will have to be blasted out.

The river is crossed by five railroad and two trolley bridges, six highway bridges, two foot bridges and two small private bridges, on many of which it may become necessary to do some work of

*The Mallet engine assumed is that of the 2:8:8:2 class on the Southern Pacific Ry. (Engineering News, Apr. 29, 1909). It weighs 213 tons, with 197 tons on the drivers and is rated to haul 1212 tons (behind the tender) on grades of 2.2%.

†From information furnished by E. M. Blake, Engineer in charge of Neponset River improvement, State Board of Health, Hyde Park, Mass.

alteration or reinforcement. Four lines of cast-iron waterpipe and two lines of cast-iron sewers cross under the river in the Hyde Park section, and it is very likely that several of these will have to be relaid at a lower elevation. Specifications have been prepared and proposals will be called for in the near future.

The construction work is all to be completed on or before Oct. 31, 1913; after that date the proportionate share of half the total cost is to be distributed among the towns and cities which are benefited by the improvement in proportion as each is so benefited, which adjustment will require accurate and painstaking work and with which in view the field work so far done was laid out.

The improvement of the Neponset River, as briefly outlined above, is the largest undertaking of its kind ever made in New England and involves the elimination of conditions which have become so intolerable that public sentiment in the cities and towns involved resulted in effective legislation. The design and construction are under the supervision of X. H. Goodnough, chief engineer of the State Board of Health, and Edmund M. Blake, engineer-in-charge.

Water Purification at Minneapolis

By J. Arthur Jensen*

A 39,000,000-gal. water-purification plant is being built for the city of Minneapolis to free the city from danger from typhoid fever and other water-borne diseases and at the same time to furnish a clear water of high general quality. The process combines sedimentation, mechanical filtration with lime and sulphate of alumina as reagents, and hypochlorite of lime as a disinfectant. The plant includes a sedimentation basin, mixing chamber, two coagulation basins, a head house, 12 filter units, two auxiliary clear water basins and a main clear water basin. The purification works will be located at the Columbia Heights reservoirs, three miles from the pumping stations, and at such an elevation that the filtered water will be supplied by gravity, as is the unfiltered water at present.

*Engineer, Water Works Department, Minneapolis, Minn.

The water supply of the city of Minneapolis is taken from the Mississippi River and the quality of the water for general purposes is satisfactory when free from contamination. The first works for supplying the city with water were begun in 1868.

With the increase of population on the drainage area and the installation of sewer systems in the cities above, the quality of the water became impaired to such a degree that the question of purification or a new supply was forced upon the municipality as a vital issue.

The appearance of typhoid epidemics brought about the agitation of various projects for the improvement of the water supply. In 1904 the city council appointed a commission consisting of City Engineer Andrew Rinker, Allen Hazen of New York City and F. W. Cappelen to investigate a number of projects which had been brought up in popular discussion.

Four different plans were considered: artesian wells, Lake Superior, Mille Lacs and the purification of the Mississippi River water. The artesian-well plan was rejected because of the hardness of the water and the uncertainty of the quantity which could be supplied. In the Lake Superior project a pipe line 160 miles in length, an elevation of the lake more than 400 ft. below the city reservoirs and intermediate high ground about 150 ft. higher than the reservoirs over which the water would have to be pumped made it impracticable on account of its excessive cost. The Mille Lacs project involved a pipe line 80 miles in length which would give the city a gravity supply, the lake being 227 ft. higher than the reservoirs. The water from the lake is similar to the water of the river save as to hardness and degree of contamination, its drainage being an adjacent portion of the Mississippi system. This plan was also rejected on account of its cost, which was estimated at $6,000,000. Mechanical and sand filtration of the river supply were investigated and the commission recommended the slow sand type of filters. Failure of the voters to authorize the issuance of bonds to finance the improvement forced the issue to rest.

In 1909 a second commission was authorized by the city council to study the subject and make a recommendation. This commission was made up of 21 representatives of various civic clubs and organizations. After several months of advice and deliberation the majority of the members reported in favor of the purification of the river water. A minority report was also submitted requesting a further investigation of the Mille Lacs project.

At this time Rudolph Hering, of New York, was engaged to investigate and report on the relative merits of the two plans with recommendations. On Mar. 17, 1910, his report was made favoring the purification of the present river supply by mechanical filtration and the use of hypochlorite of lime as a disinfecting agent.

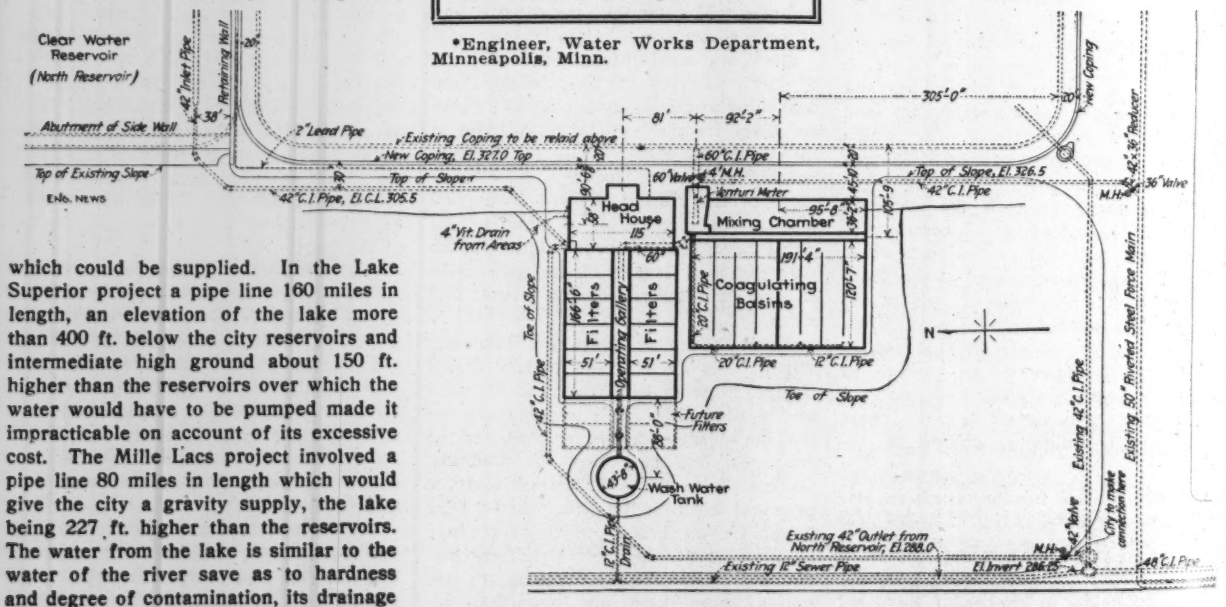


FIG. 1. GENERAL PLAN OF WATER PURIFICATION WORKS, MINNEAPOLIS, MINN.

The following table shows the characteristic constituents of the river water. With the exception of turbidity and bacteria the table is an average of several years' analyses carried on by Dr. J. F. Corbett, city bacteriologist.

ANALYSES OF THE MISSISSIPPI RIVER WATER

Chlorine	1.490
Albuminoid ammonia	0.353
Free ammonia	0.077
Alkalinity	137.000
Total hardness	145.000
Fixed residue	129.000
Volatile residue	69.000
Color	56.630
Turbidity	4.700
Bacteria	1622.000

The object sought in the treatment of the water was to remove pathogenic bacteria and give a wholesome clear sparkling water which would be acceptable to the most critical. Mechanical filtration, using lime and sulphate of alumina as coagulants, was chosen as a suitable method to give the desired results.

FIG. 2. VIEW OF PORTION OF RAISED EMBANKMENT, MINNEAPOLIS SEDIMENTATION BASIN

the river. The pumping equipment consists of two 12,500,000-gal. Worthington horizontal compound pumping engines, two Holly 15,000,000-gal. triple expansion vertical pumping engines and two 20,000,000-gal. Worthington turbine pumps driven by Westinghouse motors.

The water is pumped through a 50-in. steel force main, a distance of three miles, to the Columbia Heights reservoirs consisting of two rectangular basins each 877.5x413.5 ft. and 20 ft. deep. Each basin has a capacity of 47,000,000 gal. From the reservoirs it flows by gravity through a second 50-in. steel pipe to the distributing system consisting of 470 miles of cast-iron pipe. The supply is now being treated at the suction wells with hypochlorite of lime under the direction of Dr. J. F. Corbett, city bacteriologist. This treatment will be transferred to the filtration plant upon its completion.

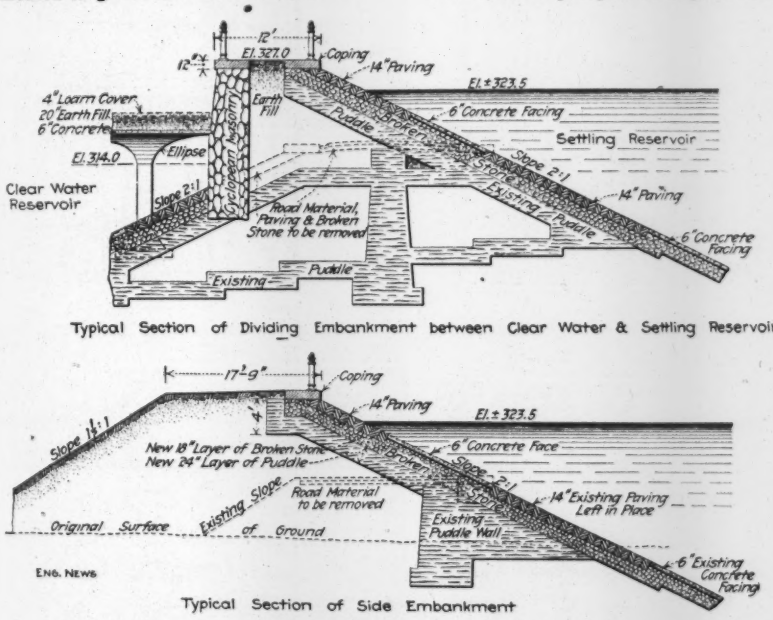


FIG. 3. CROSS-SECTIONS OF RAISED EMBANKMENT, MINNEAPOLIS SEDIMENTATION BASIN

This recommendation was adopted by the city council and Hering & Fuller were engaged to draw the plans. The estimated cost of the plant as first recommended by Mr. Hering was $522,500. This would give a capacity of 30,000,000 gal. daily. The filters were to be constructed at the present city reservoirs and be designed to operate in connection with them.

THE EXISTING WORKS

The city of Minneapolis had a population of 301,408 in 1910. The average daily consumption of water is about 22,000,000 gal., or 70 gal. per capita per day. The works comprise two pumping stations located at the upper limits of the city, one being situated on each side of

THE NEW WORKS

For practical reasons it was found necessary to modify the original preliminary plan. It was decided to maintain the elevation of the present flow line at the reservoir and to eliminate second pumping of the water at the filters. In adapting the present basins to operate in connection with the filters it seemed that one basin would be ample for all purposes as a receiving and sedimentation basin. To utilize the second basin it was proposed to convert it into a filtered water reservoir, thereby eliminating the new basin for this purpose proposed in Mr. Hering's report. In operating the two basins in this manner it was proposed to build up the embankments of the south basin 10 ft., in order to secure a working head for the filters, eliminate additional pumping and also to retain the present flow line in the north basin. During the extreme drought in 1910 it seemed wise to increase the capacity of the plant on account of the unusual demand for water. This was done, making the nominal rating of the filters 39,000,000 gal. daily. These changes were considered and embodied in the final plans.

As shown by the accompanying general plan, the purification works consists of a sedimentation basin, a mixing chamber, two coagulation basins, a head house, twelve filter units, two auxiliary clear water basins and a main clear water basin.

SEDIMENTATION BASIN—The sedimentation basin (Figs. 2 and 3) was arranged for this service by building up the embankments of the original basin, thus increasing its capacity from 47,000,000 to 75,000,000 gal. The new flow line is at elevation 324 city datum, and will give the necessary gravity working head. The original basin was built in 1896. It is rectangular in form with 2 to 1 slopes, the upper portion of which are paved with 14-in. sandstone blocks.

The slope linings are laid on 18 in. of crushed rock which insures a firm bed as

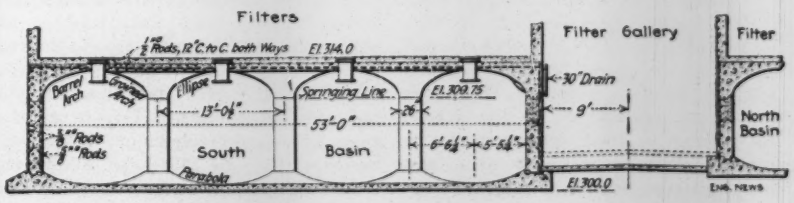


FIG. 4. CROSS-SECTION THROUGH AUXILIARY CLEAR WATER BASIN, MINNEAPOLIS, MINN.

well as a protection against heaving by frost. The lower portion of the slopes and the bottom are of 6-in. concrete slabs. The bottom slabs are on a firm foundation of hard clay. The slabs are laid in 20-ft. squares, breaking joints. An expansion joint was left 1 in. wide, filled with Assyrian and California asphalt.

In the extension work the new embankments were carried up at the same slope, making in it a puddle wall 2 ft. thick. The slopes were lined as before with crushed rock and the lower portion paved with 6-in. concrete slabs between the original revetment and the new ice breaking surface near the top. This upper portion is lined with 14-in. sandstone blocks removed from the portion of the north basin slopes which are left outside of the roof arches after making the required changes in that basin. The asphalt joints of the old basin appeared in such satisfactory condition that it was decided to make the joints of the new slabs in the same manner, and Sarco asphalt filler was accordingly used for this purpose.

The surface of the new basin will be at 324, while the average elevation of the river surface is at about 90, giving a static pumping lift of about 240 ft. (These elevations are in accordance with the Minneapolis city datum plane.) The bottom of the basin is sloped slightly for drainage and has an elevation of about 293. All of the water of the basin will not be available for service through the filters, as the outlet leading to the mixing chamber is laid with its center line at elevation 314. This outlet is a 60-in. cast-iron pipe ending in a 60x30-in. concrete Venturi meter located in the controlling chamber. This chamber acts as a receiver and permits of three separate diversions of the water, viz.: to the mixing chamber, to the coagulation basins, or direct to the filters. The coagulants can be introduced into the water in this chamber. A 42-in. bypass pipe is laid between the force main and the entrance to the 60-in. Venturi meter which permits direct pumping to the controlling chamber in case it is required to drain or clean the sedimentation basin.

MIXING CHAMBER—The mixing chamber and coagulation basins are built in one group, making use of common walls and water ways. A double-deck reinforced-concrete conduit serves to conduct the treated water from the mixing chamber through its lower passage to the coagulation basins and to receive therefrom the clarified water in the upper passage and conduct it to the filters. This conduit is fitted with gates in its various parts so as to permit of several bypassing arrangements. Water may bypass the mixing chamber, the coagulation basins or both, thereby passing direct to the filters. This feature eliminated the necessity of installing a complicated pipe system.

Normally, after being treated, the water will flow into the mixing chamber. This is a concrete basin 34 ft. wide and 173 ft. long, fitted with wooden baffles 3 ft. apart. In passing the water around the baffles a thorough mixture is insured. If it is desired not to pass the water the full length of the basin the treated water may be drawn into the lower conduit through any one of four sluice gates set equidistant along its course. In such a case the portion of the chamber beyond the first open gate will contain "dead" water, the flow traveling only to the open gate. Sluices in the baffles permit of control of the flow in the courses. Wooden baffles are used for economy in construction.

COAGULATION BASINS—The lower conduit delivers water to either or both coagulation basins, the flow entering the bottom or floor line. Each basin is divided into four parts by around-the-end baffles. The capacity of both units is 2,800,000 gal. which, at full normal filter rate, gives about 1¾ hours for coagulation and precipitation. Each basin measures 95⅓ by 119⅓ ft. At the end of its course the water passes over a skimming weir at elevation 320 and through a sluice gate into the upper conduit leading to the filters.

The floors of the mixing chambers a... the coagulation basins slope toward t... double conduit or center passage and c... be drained into sumps which have ou... lets into a 12-in. cast-iron drain pipe la... below the conduit. Flushing pipes wi... hose outlets are laid for flushing a... cleaning these basins when necessary. A... fire pump in the head house is provide... for this purpose. A 20-in. gravity flush... ing pipe is also provided for washing th... coagulation basins. The basins are of reinforced-concrete construction and on account of the winter climate which prevails at Minneapolis are covered. The roof is flat, of the beam and girder type, supported by columns 12 ft. c. to c. The walls are banked with earth on the outside and a fill 2 ft. deep is placed on the roof.

All the gates are of the sluice type and are located at the double conduit. A long gate house covers this passage and the gate stems are brought up to the floor to their several stands for convenient operation. The sluice gates were furnished by the Roe-Stephens Mfg. Co., of Detroit, Mich.

FILTERS—The filters consist of twelve units each 26½ by 51 ft. The nominal rate for each filter will be 3,250,000 gal. per day. These filters are built in two groups separated by a pipe gallery. Each group of filters is built above an auxiliary

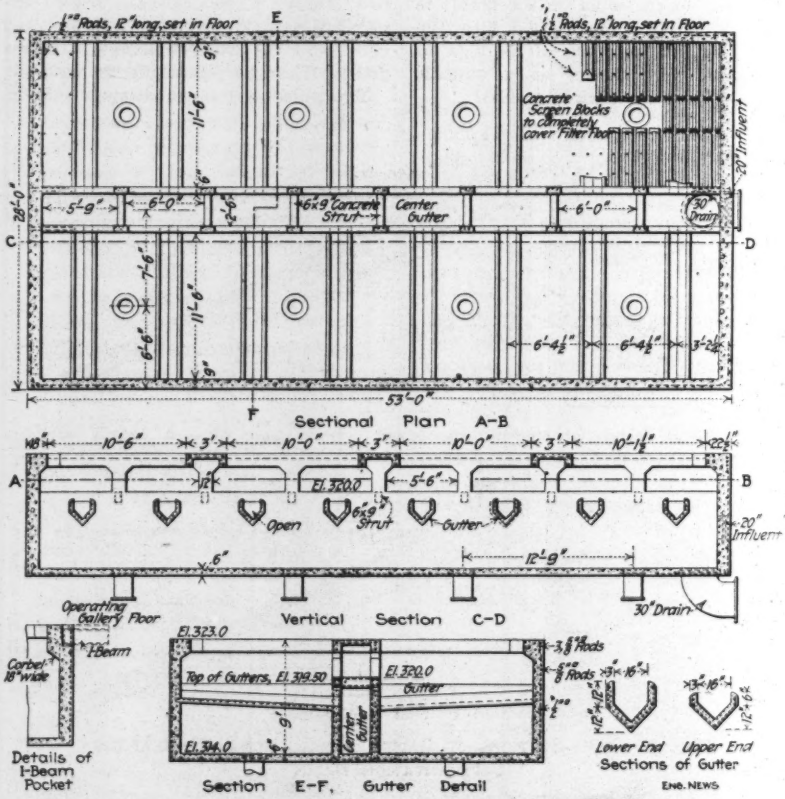


FIG. 5. DETAILS OF MECHANICAL FILTERS, MINNEAPOLIS, MINN.

filtered water reservoir of the groined arch type of construction. A partial cross-section of the auxiliary clear water reservoir is shown by Fig. 4. In longitudinal section the arch columns are spaced 14 ft. c. to c., and the distance from the center of the outer row of columns to the side wall is 12¾ ft. The length of each basin, from wall to wall, inside, is 168½ ft.

The combined capacity of these auxiliary reservoirs is approximately 1,250,000 gal. and will permit direct service should it become necessary to shut off the main clear water basin.

Each filter unit (Fig. 5) has a net filtering area of 1173 sq.ft. This area is divided into halves by a central gutter 30 in. wide to which 16 lateral gutters are connected, so spaced as to give equal distribution. These gutters also serve as collectors when the filters are washed. Each filter was built monolithic at one pouring of the concrete. Cross-walks are built above and are supported by beams and struts which serve as bracing.

The strainer system (Fig. 6) consists of ridges and grooves of concrete. The water ways communicate with each other at right angles on the line of the effluent outlets where the ridge blocks bridge over the passage formed. The water ways are covered with perforated brass strainer plates and the remaining portion of the grooves is filled with graded gravel. The gravel is held in place by brass-wire cloth having 100 meshes per sq.in. It is bolted in place at the top of the ridges by means of brass bolts set in the concrete. Upon this is placed 30 in. of filter sand which is required to have an effective size of not less than 0.35 mm. nor more than 0.44 mm. and a uniformity coefficient of not more than 1.65. The surface of the sand is at elevation 317.5 and the top of the gutters at 319.5.

A concrete wash-water tower having a capacity of 125,000 gal. will flush the filters by gravity. The elevation of this tank will produce a head of about 30 ft. at the surface of the sand.

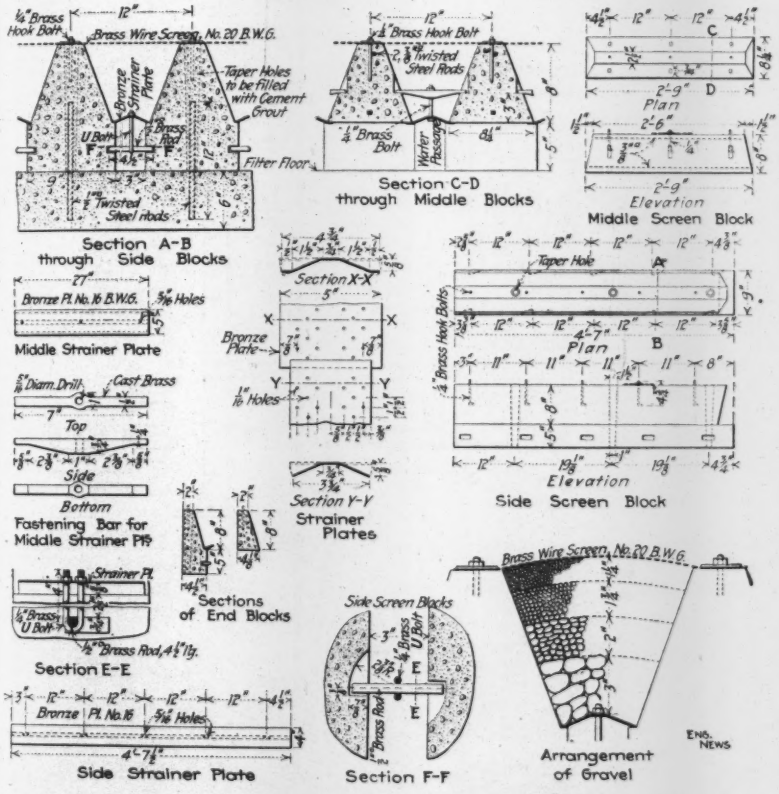


FIG. 6. DETAILS OF STRAINER SYSTEM FOR MINNEAPOLIS WATER FILTERS

In operation the coagulated water will be conducted from the coagulation basins and distributed to the filters by a 60-in. cast-iron pipe entering through the head house and suspended from beams in the pipe gallery. This enters as a 60-in. pipe and reduces to 48 in. at the end of its course. From this main, water enters the central gutter through a 20-in. pipe and the lateral gutters distribute it by overflow upon the sand. After passing through the sand and the strainer system the water is collected by eight 14-in. pipes set in the floor, forming the receiving ends of a manifold of 18-in. and 24-in. pipe. This piping brings the effluent through the gallery wall and it passes through a 20-in. Simplex meter in the pipe gallery, thence into the auxiliary reservoirs below the filters. The Simplex meter is provided with a butterfly valve to which is attached an electric motor for varying the opening at the meter. This motor is controlled by a three-way switch attached to a scale beam device actuated by the difference of pressure in the meter tube. By varying the weights on the beam the quantity of the effluent can be controlled at a constant rate.

The filtered water is drawn from the auxiliary basins through two 48x60-in. sluice gates into a concrete conduit whence it flows to the main clear water basin and also to the distribution system through 42-in. cast-iron pipes. The clear water reservoir is on a loop of this pipe and in use serves as an equalizer.

The manifold pipes under the filters also receive the wash water when the valves are properly set for reverse flow washing. The wash water is collected in the lateral and central gutters by overflow and drained away to the sewer system through a 36-in. concrete drain conduit located beneath the floor of the pipe gallery.

In the operating gallery are located the operating tables, gages and rate controller stands. The hydraulic valves are operated at the tables and provision is made for sampling the water at any time, sampling pumps being provided for the purpose, located on stands in the pipe gallery. The filter cross-walks are at the same elevation as the operating floor and all the filters are thereby readily accessible at all times. The climate required the filters to be under cover and they have accordingly been housed. The operating gallery is covered by an arched passage and a transept arch is built across the center of the floor area at right angles. The remaining portion is covered by a flat roof. In this way a clerestory is formed by means of which, together with skylights in the flat roof, ample light will be assured for proper inspection and operation of the filters.

Provision is made for increasing the capacity of the plant by the construction of four additional filter beds. Pipes have been proportioned and apparatus designed to operate the ultimate capacity.

PIPE GALLERY—The pipe gallery (Fig. 7) occupies the space between the auxiliary basins and the two groups of filters. It is 18 ft. wide by about 17 ft. high. All the pipes and valves except the collectors are located in this gallery and every part is easily accessible on account of the ample space provided. The 60-in. influent pipe, with its reducing main run and laterals, is suspended from 18-in. I-beams which span the top of the passage. Below this is suspended the 24-in. wash water pipe. The wash-water drain pipes pass down near the side

walls into the 36-in. drain conduit below the floor. The rate controllers and the sampling pumps are also located along the walls. With this arrangement a clear passage 7 ft. wide and 9 ft. high is still left through the center. All gate valves in the gallery are of the hydraulic type and are controlled at the tables on the operating floor.

HEAD HOUSE—The head house is built in conjunction with the filters and forms a part of the same structure. It is of reinforced concrete, the upper portion faced with brick, 115 ft. long and 58 ft. wide. In part it has four floors, two of which are below the surface of the ground. Fig. 8 shows a cross-section of the head house and Fig. 9 a plan of the second or chemical-solution floor.

The lower floor, at elevation 300, contains the boiler room, lime, alum and hypochlorite tanks, solution pumps, wash water pumps, lime crusher and vacuum cleaner. A sump pump will remove drainage and seepage. A freight elevator and bucket elevator rise through the house from this floor. The two lower floors will be artificially lighted and exhaust fans are installed for forced ventilation.

The second floor (Fig. 9), at elevation 309, is equipped with devices for the preparation of all the chemical solutions. The motors operating the agitators in the solution tanks are located in their respective places on the tanks which are open on this floor and a trolley system is installed to transport chemicals from storage to the dissolving apparatus. A centrifugal fire pump is located here which will ordinarily be in service for flushing the coagulation and mixing basins.

The third floor, at elevation 328, contains the offices, laboratory and chemical controllers. The main entrance is on this floor. Locker rooms, toilet, and shower baths are provided here for the employees.

An intermediate floor is located at elevation 319 as a receiving floor for unloading lime, alum and other materials. Chutes are provided on each side of the entrance for unloading chemicals from wagons. All materials will be hauled by teams to the plant, as the plant is 1½ miles distant from the nearest railroad switch. From the receiving floor the lime can be spouted to the crusher and the alum delivered direct to the bucket elevator. Hypochlorite will be handled in drums and will be transported by the freight elevator.

Twelve concrete storage bins, 10x10 ft., by 18 ft. deep, are built in the central portion of the head house. The bottom of each of these bins is built in the form of a hopper with a spout outlet on the operating floor. The lime and alum will be delivered to the bucket elevator in the basement and be taken up into the tower of the head house to a distributing spout which will deliver each chemical to its proper storage bin. Before elevating the lime it will be passed through a gyratory crusher for the proper sizing.

A high pressure water tank is located at elevation 370, in the tower of the head house, for hydraulic-gate service.

MIXING DEVICES—The hypochlorite of lime will be received in metal drums. These will be placed in a dissolving tank and submerged in water under which they are to be set up on a spindle and cut open. This will eliminate the dust and strong fumes which are encountered in handling the dry powder.

A trolley system suspended from the ceiling with weighing buckets traveling thereon will take the alum or lime to their respective mixers. The lime will be slaked in two motor-driven Chicago concrete mixers of 40 cu.ft. capacity. These mixers will discharge into a receiving trough and the solution will be screened in passing to the tanks. The alum will be delivered to two concrete mixing tanks provided with galvanized-iron pipe manifolds in their bottoms. The holes in the grids of these manifolds will be pointed downward to prevent clogging. The dissolved alum will also be screened in passing into the solution tanks.

SOLUTION TANKS—The hypochlorite and alum tanks are of rectangular concrete construction. The lime tanks are circular and are built of steel. There are three tanks for each solution. The ser-

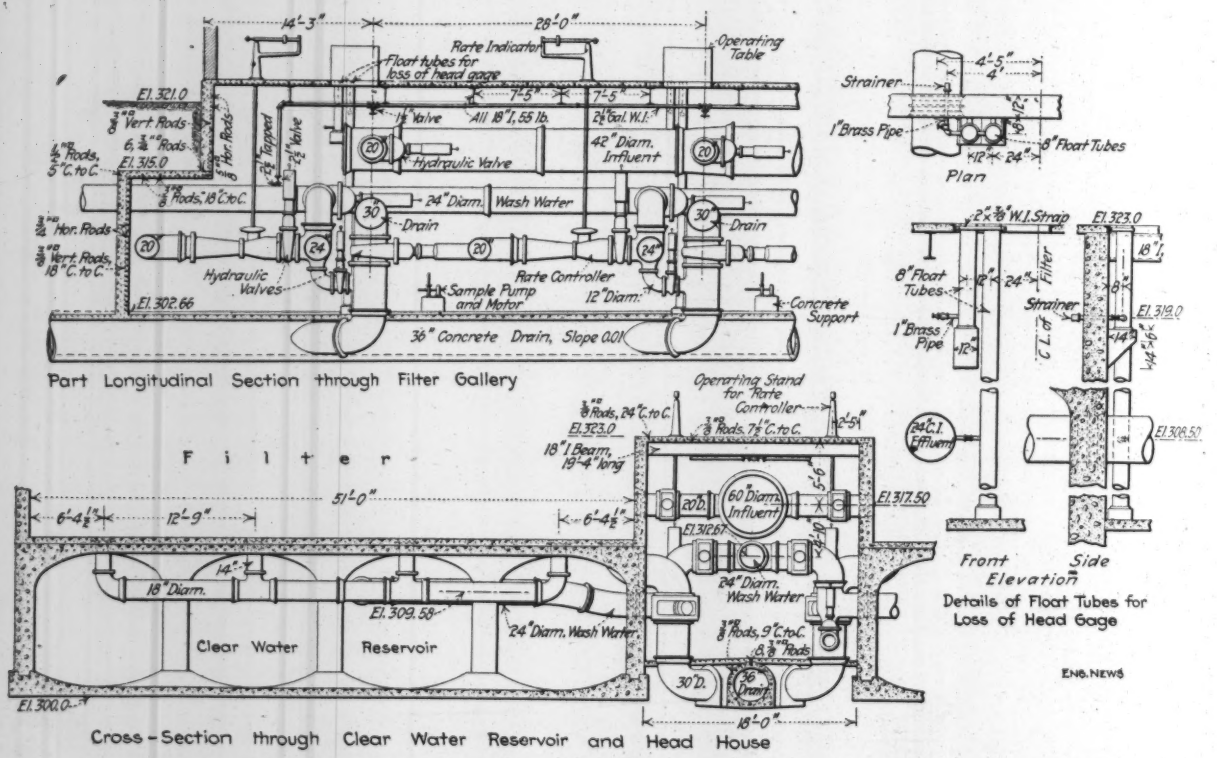


FIG. 7. DETAILS OF PIPE GALLERY AND FLOAT TUBES FOR LOSS-OF-HEAD GAGES, MINNEAPOLIS WATER FILTERS

vice capacity of each tank will be about 12,000 gal., except that the hypochlorite receiving tank will be somewhat smaller. Marine propeller agitating devices are installed in each tank, having a cone baffle open at the top and bottom. The solutions are thereby forced to circulate through the baffle vertically. In the square tanks the corners prevent swirling, while in the circular tanks a set of wall baffles gives the same effect. A 3-hp. motor on a bridge support is directly connected to the vertical shaft of the agitators on the alum and hypochlorite tanks. The lime tanks have 5-hp. power motors.

CHEMICAL CONTROLLERS—All solutions are pumped by motor-driven centrifugal pumps located in the basement. The solutions are delivered to small tanks supplying the chemical controllers. These controllers are of the Earl type operated in connection with a master controller at the 60x30-in. Venturi meter in the controlling chamber. By this arrangement the chemical feed will be in exact ratio to the quantity of water flowing into the controlling chamber. The line will be added to the water at the entrance to the mixing chamber, the alum at the central passage and the hypochlorite in the effluent conduit.

VACUUM CLEANER—One of the novel features of the plant is a vacuum cleaner for sweeping and dusting. The cleaner and motor are located in the basement and pipes are run to the various floors of the head house and the filter-operating floors, with outlets for the sweepers connected where they are desired to be used. This sanitary precaution will prevent dust and other foreign matter from entering the water and the solutions in preparation since it eliminates the use of the broom.

PUMPS—All pumps are of the centrifugal type and direct connected to their motors. Two 8-in. pumps, each having a capacity of 1600 gal. per minute, will supply the wash water tank with filtered water for washing purposes. The flushing pump has a capacity of 500 gal. per minute under 100 lb. pressure. The solution pumps have a capacity of 40 gal. per minute. All the pumps are of the Buffalo type and are connected to Westinghouse motors. These pumps, together with the chemical controllers, operating tables, trolley system and hypochlorite dissolving devices were furnished by the Pittsburg Filter Mfg. Co. The strainer plates, screens and chemical agitators were furnished by the American Water Softener Co. The hydraulic gates are of the Eddy type and were furnished by J. B. Clow & Sons.

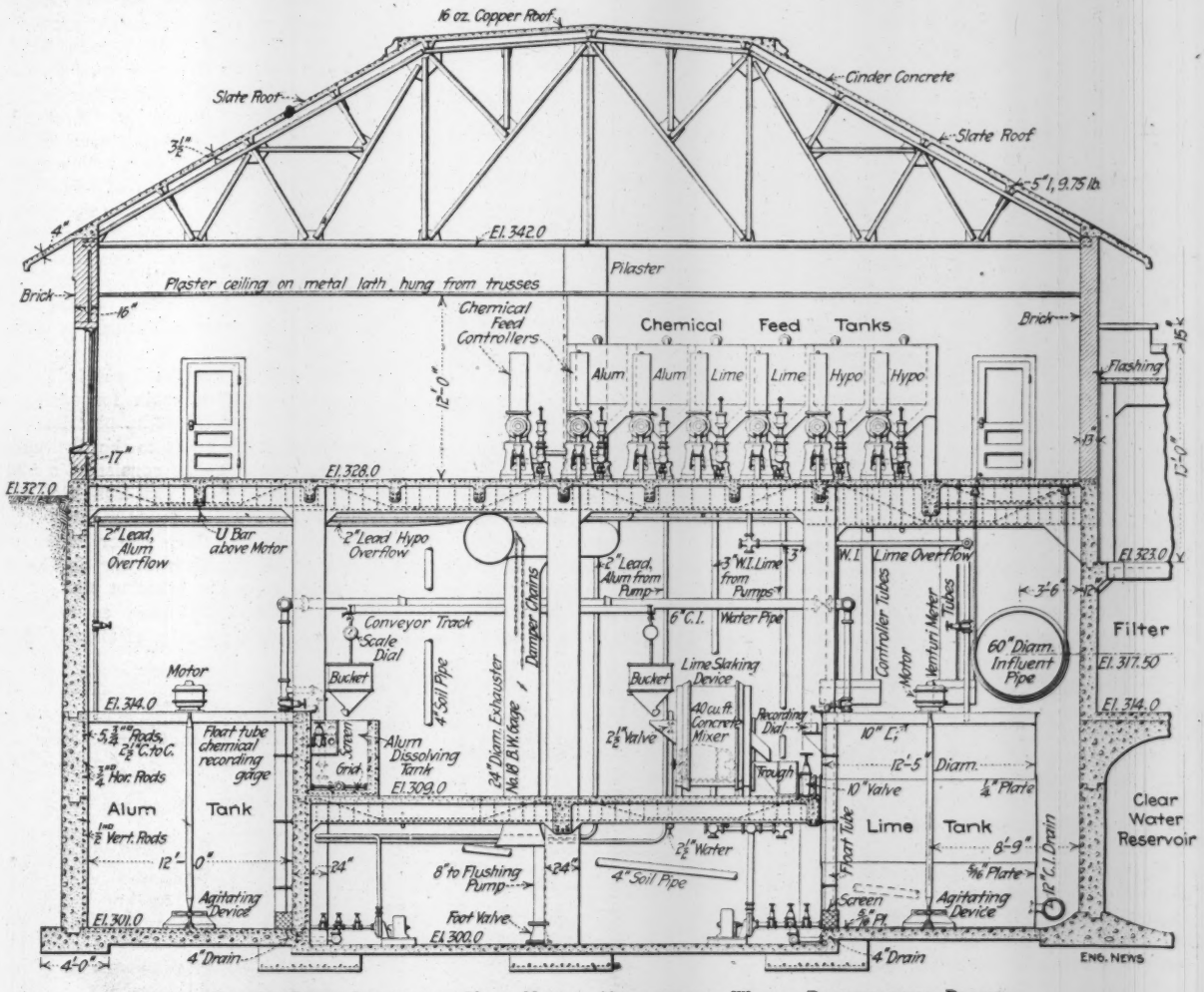


FIG. 8. CROSS-SECTION OF HEAD-HOUSE, MINNEAPOLIS WATER PURIFICATION PLANT

LABORATORY—A laboratory is located on the upper or ground floor. This is arranged separately for chemical and bacteriological work and will be complete in every detail. An independent gas plant is provided for laboratory use, as the filters are located several miles from the nearest city gas supply.

The laboratory communicates directly with the operating floor of the filters and the room containing the chemical feed controllers. Twelve sampling pumps will supply the laboratory with water from the filters and the solutions can be sampled at the controllers for testing. The labora-

tory is also located so as to give the chemist north light for his work. A room is provided adjacent to the laboratory at the front for the office of the superintendent.

FIG. 10. PEDESTALS READY FOR COLUMNS FOR SUPPORTING GROINED ARCH ROOF OF MINNEAPOLIS CLEAR WATER BASIN

WASH WATER TANK—The wash water tank is of reinforced concrete, circular in form, with an inside diameter of 42 ft. and a depth of 13 ft. The substructure below the tank gives two stories, the lower of which forms a sump to receive the wash water waste from the filters. This is necessary because the drain leading from the plant to the river is not large enough to take the water at the rate at which it comes from the filters, but this flow being intermittent, the sump is made of sufficient capacity to hold the waste water while the drain has time to conduct it away. On the ground level is located the intermediate floor which will be used for storage.

The superstructure of the tank is inclosed in a wall of paneled brick harmonizing with the brickwork of the main buildings. A 24-in. cast-iron pipe delivers the water to the filters by gravity for washing.

POWER—The city has a contract with the General Electric Co. to furnish power to the plant and to insure against interruption in cases of emergency a duplicate power line is provided.

BUILDINGS—The buildings and gate house are of red brick laid up in panels in Flemish bond. The flat roofs are of concrete and tar construction. The steep rooms are of cinder concrete construction covered with slate.

CLEAR WATER RESERVOIR—In providing a clear water reservoir it was decided to utilize one of the existing clear water basins. To make it suitable for the storage of filtered water it was necessary to cover it with a roof. This roof is of the groined-arch type and has an area of about eight acres.

Pedestals (Fig. 10) having a base 6½ ft. square and 3½ ft. high were built on 18-ft. centers. These bases were set on the bottom slabs of the old basin, as these serve to distribute the load of the roof over a wider area than the pedestals themselves. Columns 20x20 in. and averaging about 18 ft. in height support the groins. The arches have a rise of 3½ ft., and are elliptical on the inside and parabolic on the outside. The thickness of the arch at the column is about 24 in. and at the crown 6 in. Manholes are placed at intervals in the roof for ventilation and lighting when necessary to work in the basin.

The roof terminates in a barrel arch at the slopes of the sides and north end of the basin. At the south end the thrust of the roof is taken directly by a massive concrete retaining wall which was built to support the roof on the north side and to cut off the raised embankment of the settling basin on the south side. All the concrete work in this roof work is plain and contains no reinforcement. At the sides the arches rest on the original sandstone revetment and that portion of the old revetment left outside of the arches was removed and used in completing the slopes of the extension work in the sedimentation basin. A covering of 24 in. of earth was placed on the arches of the roof as a protection against contamination and action of frost.

Water reaches the clear water basin through a 42-in. cast-iron pipe and is distributed in the basin through eighteen 12-in. openings in a 42-in. concrete conduit built across the end of the basin and forming the terminating end of the effluent pipe.

The outlet from the basin is through the existing 42-in. main for service to the city. A second 42-in. pipe leads directly from the filters to the distribution mains. These mains consist of a 50-in. steel and a 48-in. cast-iron pipe connected at the distributor. By this arrangement the clear water basin will serve as an equalizer in the distribution of water from the filtration plant.

The clear water basin as now constructed has a capacity of about 45,000,000 gal. and is one of the largest covered filtered water basins in the country.

Work began on the project in July, 1910. At the present time (May, 1912)

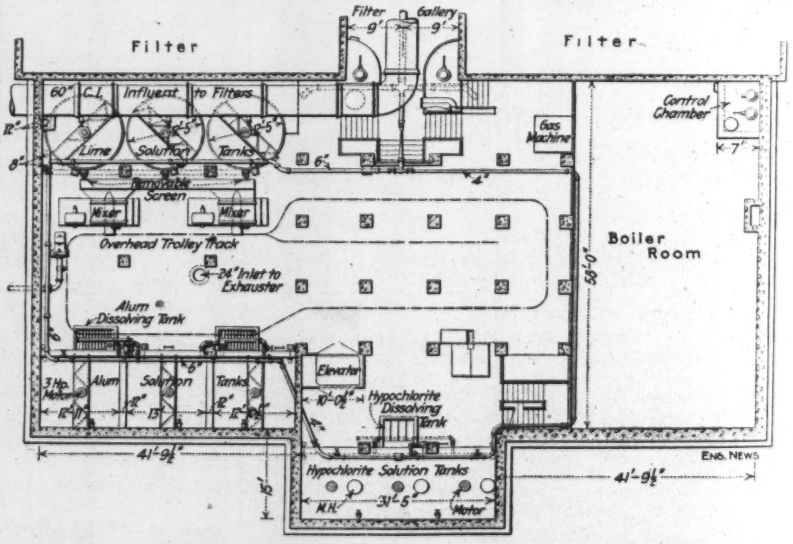


FIG. 9. PLAN OF SECOND OR CHEMICAL SOLUTION FLOOR OF THE HEAD-HOUSE OF THE MINNEAPOLIS WATER PURIFICATION PLANT

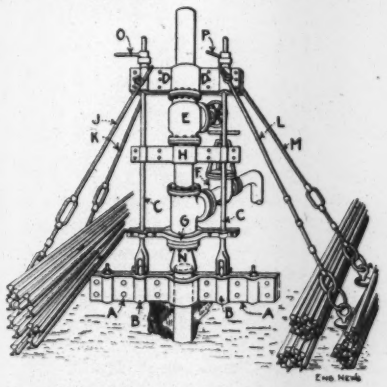
the sedimentation basin is nearly completed. The covered clear water basin was ready for service in December, 1911, and the head house and filters are now being roofed. All the piping in the filters and a portion of the strainer system and operating apparatus have been installed. The walls of the coagulation basins and the mixing chamber are in course of construction and the wash-water tower is well under way.

It is expected that the final connections will be made and the plant put into operation in September, 1912.

The plans were prepared by Hering & Fuller, consulting engineers, New York. The construction work is done by day labor by the city of Minneapolis under the direction of Andrew Rinker, city engineer. In the field W. N. Jones is superintendent of construction, A. W. E. Fawkes is assistant superintendent. J. A. Jensen is engineer of the water-works department.

Closing a Spouting Oil Well

Closing a well which is spouting a heavy flow of oil under high pressure is a difficult problem which has had to be solved many times in the oil districts of this country. In *The Engineer* (London) of May 17, 1912, we find a description of the method employed to close such a well at Potrero del Llano (Vera Cruz), in Mexico. The well was spouting for 108 days, and it is estimated that some 10,800,000 barrels of oil were discharged



METHOD OF CLOSING A "GUSHER" IN A MEXICAN OIL DISTRICT

before the well was closed; all of this was lost, except about 3,000,000 barrels held in a temporary reservoir. The oil was struck at a depth of 1900 ft., and the flow rapidly increased from 10,000 barrels to the enormous amount of 160,000 barrels per day. The device used to close the well is shown in the accompanying cut, and is described as follows:

In the well were about 1700 ft. of 8-in. casing. First of all a heavy clamp in halves was placed so as to embrace the top of this casing where it projected above ground level. This clamp *AA* carried two eyes *BB* which were used as hinges for two 2-in. rods *CC* having the upper ends threaded. The upper ends of these rods were passed through a clamp *DD* above an 8-in. T-piece, which was provided with two 8-in. stop valves *E* and *F*, one being on an arm of the tee and the other on the tail. Two other clamps *G* and *H* embraced the T-piece so as to give increased rigidity. The top clamp *D* was provided on both sides with hooked tie-rods *J*, *K* and *L*, *M*; these were hitched to turnbuckles, the lower ends of which were connected to anchorages of concrete firmly embedded in the ground and weighted down with many tons of rails. At the lower end of the arm of the T-piece, which it was intended should finally come above the orifice of the well, was fixed a short length of pipe *N* tapering from 10 in. to 8 in.

When all was ready the apparatus was laid on its side in correct position near the well, and by the aid of guy ropes was gradually raised until vertically over the spouting bore hole. The valve *E* was kept open so that there was unobstructed egress for the oil. By means of the spanner levers *O* and *P* the nuts on the threaded rods *CC* were tightened by degrees, and the taper nipple *N* was gradually brought down over the well casing, packing being inserted so as to make the joint as tight as possible. The operation was entirely successful. When the valve *E* was gradually closed and the valve *F* opened the oil was found to be quite under control and could be diverted into the reservoir.

The apparatus had been tested to a pressure of 800 lb. per sq.in., and as the pressure in the well was thought to exceed this, it was decided to install another apparatus with pipes and valves tested to 2000 lb., since it was deemed unwise entirely to close the well with the weaker apparatus. This was successfully done, and now the well can be entirely closed if desired, and there is, apparently, only a slight leakage at the joints. The pressure when the well is closed is found to be 825 lb.

By means of the first apparatus the flow was immediately reduced to 8000 gal. per day, and was kept at this until proper storage could be provided. The temporary storage reservoir referred to above was rather over 60 acres in extent, but in 60 days this was filled with 3,000,000 barrels of oil, though the flow was checked as much as was deemed advisable.

The Origin and Composition of Icebergs was discussed by Sir Clements Markham in a recent lecture before the British Royal Societies Club. The following notes are taken from an abstract of this lecture in "The Engineer" (London): North Atlantic icebergs come chiefly from Greenland. This country is a mass of plutonic rock covered with ice to a depth of 8000 ft. The snow converted into ice by pressure has, in the course of ages, filled all the valleys and covered the mountain tops, forming a great plateau far above them.

On the western coast are deep fiords, some of which extend 80 or 100 miles inland. The ice is pushed along these fiords toward the coast by the enormous weight of the ice behind. At the ends of the fiords are walls of ice rising abruptly from the water, and from these walls the icebergs are thrown off. There are eight principal discharging glaciers on the west coast of Greenland. The rate of movement is in some cases 28 yd. per day. Considerable streams of water flow under the discharging glaciers to the sea.

A discharging glacier has a thickness, upon reaching the sea, of 1000 ft. or more. It continues to slide along the bottom until it has "picked up" enough buoyancy to lift it and then continues to advance until the action of wave and tide breaks off the foremost part. At its birth, an iceberg will be at least 1000 ft. high as well as in length and breadth.

The icebergs are discharged from the fiords in great numbers, are carried by the current of Baffin's Bay and Davis Strait into the Atlantic. In the open sea their size is rapidly reduced by weathering and by the melting of the part below the surface. Eventually they lose their equilibrium and capsize, bringing the under-water part above the surface. Often a large piece breaks off from the parent berg. This is called "calving."

The color of an iceberg is opaque white, like hand-pressed snow. Scattered through the mass, and sometimes visible on the surface, are strata of deep blue ice, varying in width from one to several feet. These may be formed by the filling up of fissures in the inland ice with water. The peaks of newly formed bergs attain heights of over 300 ft., and they are hundreds of yards in circumference at the water line. Only one-seventh of their bulk appears above water.

When the field ice breaks up in summer, the current takes the bergs into the Atlantic, either to ground on the banks of Newfoundland or to float southward until picked up by the Gulf Stream. Icebergs have been reported as far south as 38° 40'.

A Projecting Lantern for Opaque Objects of comparatively large size is described in a communication from the technical bureau of the Bausch & Lomb Optical Co., of Rochester, N. Y. The original model was developed for the National Cash Register Co., for use in explaining the mechanism of the cash register to its salesmen. A section of a cash register was placed in the instrument and was shown on the screen with the mechanism in operation.

The objects to be projected are placed on a horizontal table whose height can be adjusted by a handwheel. Objects of any size up to 20 in. square by 9 in. thick can be accommodated. The illumination is provided by two large arc lamps mounted above the table and throwing rays of light from opposite sides at angles of 45° with the horizontal. The image is projected vertically upward through a photographic anastigmat lens of 19¾-in. focus and 4⅞-in. diameter. An adjustable mirror is mounted above the lens to direct the image toward the screen. It also serves as a reversing mirror to counteract the inverting effect of the lens. The object is shown on the screen in its natural colors. The arc lamps give sufficient illumination, it is claimed, with 50 amp. of current, 25 amp. to each lamp.

Kingshighway Viaduct, St. Louis, Mo.

By Mont Schuyler*

Kingshighway Viaduct is a monumental concrete structure forming part of the new boulevard system of the City of St. Louis. An effort has been made in its design to produce an architecturally pleasing bridge, as well as one fulfilling all the structural requirements. Mr. Schuyler describes in some detail both the design and the construction of the viaduct.

*Engineer in Charge, Municipal Testing Laboratory, St. Louis, Mo.

Kingshighway Boulevard, projected to extend from the Chain of Rocks Park at the extreme north to Riverside Park in the southern portion, forms the backbone of the boulevard and park system of St. Louis. With its several branches, existing and projected, it will constitute a pleasure drive of upward of 18 miles and will serve to connect the larger parks as well as furnish a main business thoroughfare north and south for the western part of the city. At about the center of its length it crosses a shallow valley entirely given over to the railroads and industries where the unattractiveness of the crossing is indisputable.

In 1902 a commission appointed to study the boulevards and to report suggestions for the treatment and extension of the existing system, presented several monumental designs for a structure to carry Kingshighway Boulevard across this valley, the estimated cost being in the neighborhood of $600,000, but nothing came of these efforts. For the Louisiana Purchase Exposition, of 1904, a temporary crossing was made by erecting a wooden viaduct with short earth filled approaches and crossing the tracks on I-beam girders. Considered merely as temporary, it served its purpose satisfactorily, though at the time of its demolition to make room for the new structure, the maintenance cost was excessive.

Studies were made in 1907 for a concrete viaduct which was to cross the valley with a single span of 300 ft., and with a 30-ft. rise. The short length (1600 ft.) and clearance of 17 ft. demanded at the spring line necessitated excessive grades, while the length and flatness of arch resulted in such thrust intensities that the cost of the piers and abutments would have been excessive, bedrock lying 120 ft. below the surface. Subsequently, a design in steel was abandoned, on account of the impossibility of keeping its lines in conformity with the monumental nature of the projected boulevard.

Finally, in 1910, the design now being completed was adopted. This consists (Fig. 1) of a main span of 170 ft. flanked on each side by a lateral span of 140 ft., six arches of 25 ft. each, grouped in pairs, and an extended approach of earth fill between retaining walls.

A solid arch ring was selected in preference to a ribbed arch, which last, though decidedly more economical, would have increased the approach grades due to the necessity of maintaining a minimum clearance of 17 ft. above rails at the spring line. It was thought, also, that the flat arch would minimize the nuisance due to pocketed smoke. The material used throughout is reinforced concrete. The overall width was fixed at 88 ft.

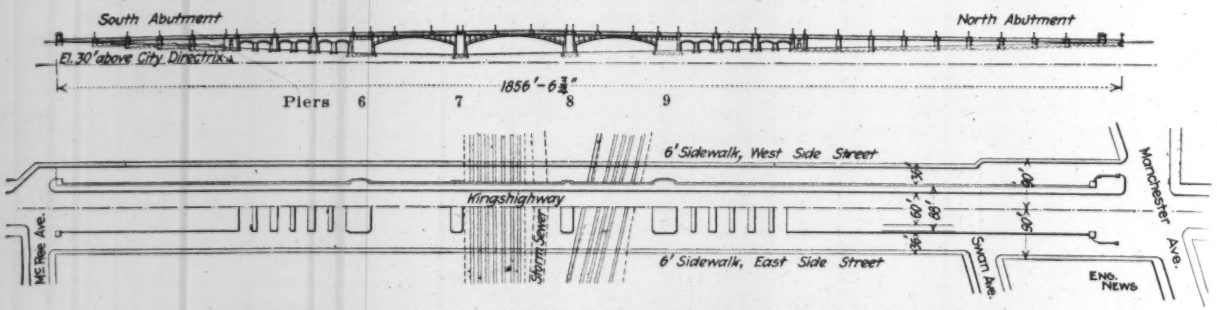


FIG. 1. GENERAL ELEVATION AND PLAN OF KINGSHIGHWAY VIADUCT, ST. LOUIS, MO.

DESIGN

FOUNDATIONS—The elevation of the floor of the valley at the center line of the boulevard is about 45 ft. above the city datum. At about elev. 20 at Pier 6 and at elev. 22 at Pier 9 is found a stratum of shale of dense structure as it lies in its natural bed, but readily disintegrating upon exposure to the weather. This layer is approximately 32 ft. thick. The footings of the four main piers were designed to rest at 6 to 8 ft. below the surface of the ground upon reinforced-concrete piles driven to refusal into this shale. The general character of the borings gave every evidence that this would result in a thoroughly rigid foundation, though provision was made in the specification for any necessary extension.

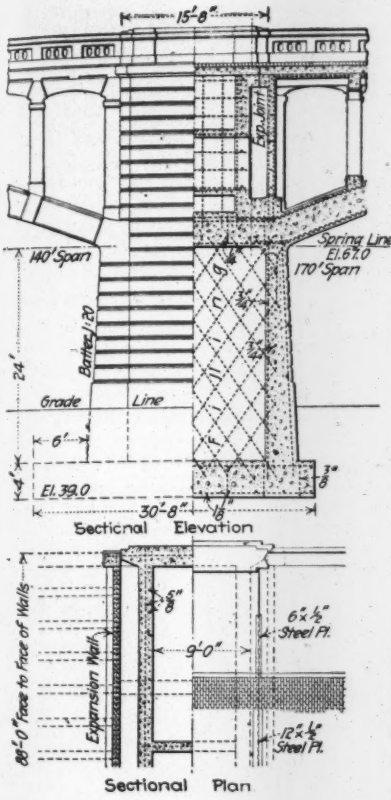
The piles were to be reinforced for the top 5 ft. of their length, the reinforcement to extend 3 ft. into the footing slab. They were to be driven 5 ft. on centers following the order given on the plans. The specifications demanded that piles molded in place should be of 8-in. point and 20-in. head diameter. Piles molded before driving might vary, but the aggregate area should equal that shown on the plans. On account of difficulties afterward explained, this design has been changed.

The further design of the main piers is shown in Figs. 2-3. As noted there, they are of cellular construction filled with earth. At the elevation of the arch entrance the piers are capped with a horizontal diaphragm, the reinforcement of which consists of the stub extension of the arch-ring reinforcement.

These cellular piers were filled with earth and, together with their cellular extension to the floor-slab level, are calculated as elastic gravity sections resting upon an incompressible base and taking up the entire arch thrust; no reliance being placed in the approach arches and filled approach acting in any degree to absorb a portion of the arch ring thrust of the main system.

ARCHES—The three main arches and their piers were designed as a single elastic system. The more usual theories of the design of an elastic arch were not used, but an original graphical application of the theory of the "ellipse of elasticity" was employed. This method has been used in the design of one or two riveted trusses in Italy and elsewhere, but it is believed that the application of this theory to the elastic arch is unique. A paper fully descriptive of this method is being prepared and will be presented shortly before some technical society; it is too extended for presentation in this limited space.

In the arch rings the combination of steel and concrete is used to the best ad-



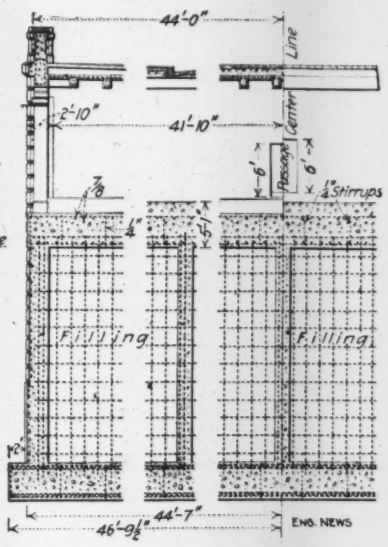


FIG. 2. DETAILS OF MAIN PIERS (NOS. 7 AND 8)

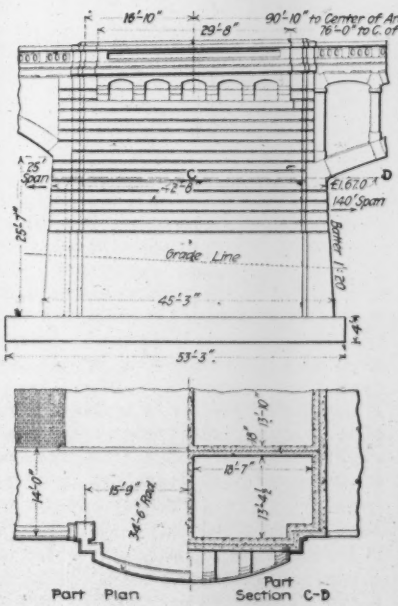
vantage, by allowing the steel of the arch ring to take tension under certain extreme conditions of temperature and live loading. The upper steel of the 170 ft. arch at the spring is under 7000 lb. per sq.in. tensile stress, when a temperature of 40° F. is combined with three-quarters live load evenly distributed and a concentrated live load of 50 tons on four wheels 28 ft. 3 in. from the spring.

This daring, though rational, use of this combination of materials, allows, in this particular case, a peculiarly light and graceful arch. The more usual rule, i.e., that all arch-ring stresses should be compressive, would have increased the thickness at spring 55%. Under dead load the force polygon remains entirely within the middle third.

The transverse width of piers was selected with the idea of preserving esthetic unity. It was found, however, upon calculating the resultant of the thrusts of an adjoining pair of arches, that the thrust vector passed the footing slab of Pier 8 near the middle of the outer third under certain live loading assumptions. To remedy this the footing slabs were increased in width as shown in Fig. 3, and the 140-ft. lateral arches were overloaded with a lean concrete to the degree necessary to restore the thrust vector to its correct position, i.e., within the middle third of the footing slab. Under the dead load only, the resultant vertical-thrust vector is less than 0.1 ft. from the geometric center of the footing slab, while under the most adverse loading assumption there is about 7½ lb. per sq.in. tensile stress at the point where the transverse pier wall adjoining the 170-ft. arch connects with the footing slab.

LOADINGS AND UNIT STRESSES — The uniformly distributed live load was taken at 150 lb. per sq.ft. In addition, the influence of a moving load of 24 tons on four wheels (10 ft. axle to axle and 4 ft. tread) was considered, no allowance being made for impact.

The unit stresses used were 800 lb. per sq.in. in the concrete and 12,000 lb. per sq.in. in the steel, including stresses generated by a temperature change of 60° F. The possible tensile resistance of the concrete was neglected.



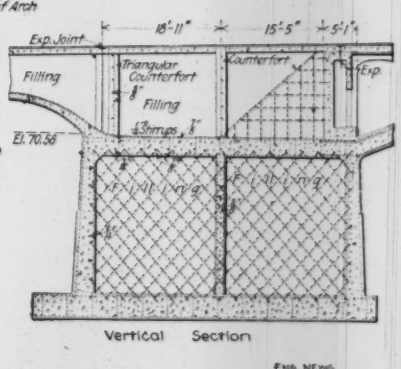


FIG. 3. DETAILS OF PIERS 6 AND 9

DESCRIPTION OF STRUCTURE

MAIN ARCH SYSTEM—The details of the arch reinforcement may best be gathered from Fig. 6. The spacing shown allows sufficient clearance for the deposition of the concrete and was justifiable since there is little necessity for adhesion bond, the maximum shearing stress being but 10 lb. per sq.in. The steel percentage at the spring is 2.35, and is probably as near the point of maximum economy as is ordinarily practicable in this class of structure. At the key the percentage of reinforcement is 1.85.

The columns carrying the floor system rest upon sills 18 in. wide, which extend the full width of the arch ring and were cast at the same time. An indication of a secondary key is given on the vertical face of the arch ring at these points. The sills acting as beams to distribute the column load concentrations across the width of the arch ring are reinforced longitudinally at top and bottom. The design of the remainder of the members may be best noted on Fig. 6.

Provision for temperature changes in the length of the floor system is accomplished in a very effective manner. The true faces of the piers are masked at a distance of 2 ft. 1 in. with walls 8 in. thick, resting upon the thrust diaphragm at the spring and extending practically the full width of the viaduct. These walls carry the floor system at their tops, and are so reinforced that they possess not only the requisite section to carry the reaction of the adjoining floor slabs, but also are capable of suffering the distortion imposed upon them by the expansion and contraction of the floor system, as well as the displacement of the crown of the arch due to a change in temperature. The columns supporting the floor system between walls and keys act in a similar manner, their varying lengths due to the fall of the arch toward the spring, allowing them to take the summation of the

expansion increments with a practically identical unit stressing.

SECONDARY ARCHES AND APPROACHES—The six small arches flanking the 140-ft. lateral arches of the main system are grouped in pairs. (Fig. 7.) The piers are of a cellular construction similar to that employed in the case of the main system, though their footing slabs are not carried on pile extensions to the indurated clay, but rest directly upon the subsoil at varying elevations about 4 ft. below ground level.

The piers serving to separate the approach arches into pairs are 11 ft. at the spring, while the remaining piers, at this elevation are 6 ft., walls perpendicular to the bridge axis being battered to the same degree as those of the main piers. Similar thrust diaphragms to those employed in the main system serve to absorb the horizontal component to the arch ring thrusts.

These arches are of 25 ft. span, 5 ft. rise and are 1 ft. 9 in. thick at spring and 1 ft. at key. The roadway base over approach arches and for the filled approach will be carried upon an earth fill between spandrel and retaining walls.

The expansion of these spandrel walls is taken up in ¼-in. clear joints between the double buttresses over the heavier piers of the secondary system. These joints, as are those of the filled approaches, are backed by 2 in. of a special asphaltic cement lapping the joint 6 in. on either side. The details of this section of the viaduct are given in Fig. 8.

These secondary arch systems are followed by approach terminal piers, which, though purely ornamental in their nature, serve to provide four rooms, 10x12 ft., which are entered by cast-iron doors opening upon the side roadways and will be used to store the tools necessary for the maintenance of the viaduct.

All retaining walls of the filled approach, except that part forming a portion of the approach terminal pier, which is buttressed, are calculated as gravity sections. Typical design is shown in Fig. 8.

Where the height of the retaining wall exceeded 11 ft. the construction was cellular, clay filled. Diaphragms closed each double panel length and were inserted at distances of 18 ft. 2 in. where the height of wall did not exceed 17 ft., and at distances of 21 ft. 5 in. for the higher portions, being 10 in. and 12 in. thick, respectively, and tying face and back wall by means of ½-in. rounds, 2 ft. on centers vertically. At each panel length an expansion joint, as described above under "Secondary Arches," was provided for between the closing diaphragms.

The remaining length of retaining wall was designed as a buttressed wall, being appropriately tied to the footing slab.

Extensive provisions were made for the drainage of piers and fills, porous drain tile being used.

SPECIFICATIONS

The aggregates obtainable in St. Louis are of excellent quality but occasionally run to the smaller sizes and frequently are composed of one sized particles, generally of medium dimensions. An investigation carried on by the City Testing Laboratory during the previous year formed the basis of the specification finally adopted for these materials; separate and distinct, though related, gradings being given for three classes of coarse and one fine aggregate. The following specification for coarse aggregate of a maximum size of 2½ in. is typical.

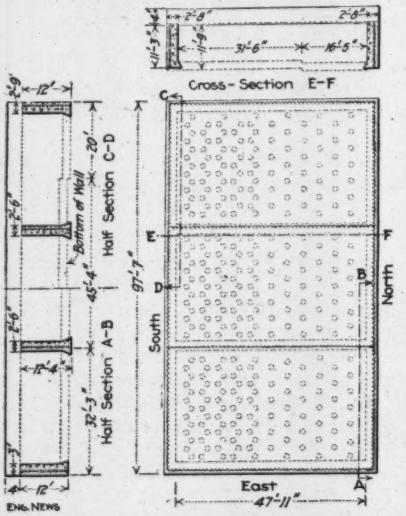


FIG. 4. DETAIL OF FOUNDATIONS OF PIERS AS BUILT AFTER PILE FOUNDATION WAS REJECTED

(Former piles shown dotted.)

Where coarse aggregate of a maximum size of 2½ in. is specified, it shall be so graded that:

One hundred per cent. will pass a ring 2½ in. in diameter. Not more than 58% nor less than 46% will pass a ring 1½ in. in diameter.

Not more than 26% nor less than 19% will pass a ring ¾ in. in diameter.

Not over 5% will pass a ring ⅛ in. in diameter.

It may be deduced that the straight-line grading is followed for the coarse aggregates. The parabolic grading is demanded for the fine aggregates. The specification in effect places a maximum upon the percentage of particles of a size midway between the largest and smallest, while allowing considerable latitude for the last named sizes.

The method of specifying the mixture to be used is a modification of one developed and used with a great measure of success by H. C. Toensfeldt, Commissioner of School Buildings, Board of Education of St. Louis, and is given here in full.

CONCRETE WORK

Wherever the term "concrete" is used herein, an intimate and homogeneous mixture of cement and aggregate with sufficient water is desired.

Where coarse aggregate of a maximum size of 2½ in. is specified, the volume of fine aggregate, measured loose, shall equal 40% of the volume of coarse aggregate, measured loose.

Where coarse aggregates of a maximum size of 1½ in. or ¾ in. are specified, the volume of fine aggregate, measured loose, shall equal 50% of the volume of coarse aggregate, measured loose.

The concrete in the various parts of the structure shall be proportioned as follows: Column "A" gives the maximum size of aggregate to be used, and column "B" the number of cubic feet of concrete in place, which contains 94 lb. (one sack) of cement.

	"A" (in.)	"B" (cu. ft.)
Piles	1½	5.2
Concrete footing for four main piers	2½	8
Concrete footing for all other piers	2½	8
Piers from footings to spring line	1½	7
Retaining walls and footings	1½	5
Horizontal diaphragms at spring line	2½	4½
Barrels of all arches	1½	4½
Four main piers above diaphragm	1½	5
Sill beams on extrados of 170-ft. arches and 140-ft. arches and vertical posts	1½	5
Beams and slabs, floor system 170-ft. and 140-ft. spans	¾	5
Concrete filling (plain)	2½	8
Hand rail	¾	5.15
(Volume of fine aggregate to be 100% of the volume of coarse aggregate.)		
Monumental entrances	¾	7
Expansion wall	⅛	3.3
Facing mortar	⅛	2.2

A simplification of this method of specifying the mixture has since been adapted as standard by the "Organization of City Officials."

The reinforcing bars were specified to be of mild steel having an ultimate strength between 70,000 and 80,000 lb. per sq.in. and an elastic limit at least half of the ultimate strength. The bars should bend cold 180° about a mandrel of an equal diameter. An elongation of 22% in 8 in. was also demanded. Bars should be of an approximately circular section and possess corrugations to provide mechanical bond.

It was found practically impossible to obtain steel of these characteristics. While retaining the clauses referring to cold bending and elongation, the tensile characteristics were altered to allow the acceptance of steel possessing an elastic limit of 30,000 lb. per sq.in.; no demand being made for any definite ultimate strength. Considering the method of design and the low working stress selected for this material, this change seems rational.

Some difficulty was experienced in obtaining bars of the minimum net section demanded by the specifications, i.e., at least 97% of the area shown in the drawings. In construction of the dimensions of the arches designed for this viaduct, stiffness, which can only be secured by section, is a paramount necessity. In all parts of the work, except the arch rings, extra bars were inserted where the section fell below that prescribed. In the arches the spacing was so close that this expedient became impracticable, and

after special effort, the supplying company succeeded in obtaining bars acceptable in this respect.

On this work, as is necessary in all St. Louis city contracts, cement was delivered in paper sacks, each sack bearing the stamp of the Board of Public Improvements and a serial number changing with each car-load lot and serving to identify the bin of accepted cement from which the lot was shipped.

All quantities were specified by the cubic foot. This is perhaps a more rational procedure than the generally accepted convention of giving measurements in feet and inches and payment by cubic yards.

For reasons of economy the contract allowed the construction of the arches of the main system and the floor system in two sections, divided by the vertical plane through the axis of the viaduct.

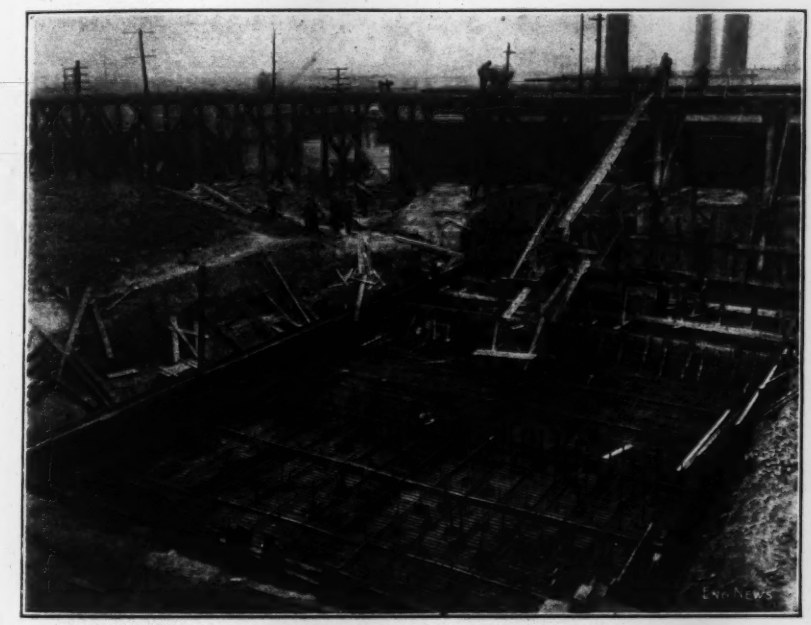


FIG. 5. VIEW OF FOOTINGS OF PIER NO. 6
(Showing at left old pile footings and at right new cross-walls.)

Bids were opened June 27, 1910, for excavation, construction of the concrete footings, piers, arches, etc., and the W. P. Carmichael Construction Co., with a unit piece bid of about $336,000 based upon the estimated quantities, was awarded the contract.

CONSTRUCTION

FOUNDATIONS — Before the demolition of the then existing wooden viaduct, a roadway of vitrified brick on a concrete base was constructed to the west. Excavation was started at Pier 6, the south pier of the main system, by teaming, and by skip and derrick at the lower levels. Pier 9 was partially excavated by traveling crane and grab bucket.

Piling was started at Pier 6. At this point the strata of shale in which the piling were expected to find bedment lay 23 ft. below the floor of the pier excavation.

Practical refusal (20 blows per in.) was met in all cases at a penetration of approximately 12 ft., a 5-ton steam hammer between guides being employed. Using the ENGINEERING NEWS formula this indicated a safe bearing load of 80 tons per pile.

The driving pattern, a system of equilateral triangles of 5 ft. sides, was followed, when a series of level readings showed that the ground surface was rising, not only around the piles being driven, but at some distance therefrom.

Four loading tests were made, first of isolated piles and then of groups. The first isolated pile tests gave a total penetration of 10 in. under a dead load of 40 tons. The designing load per pile being 50 tons, extra piles to an amount equalling 50% of the original number were ordered driven.

In making the group test, certain piles in the group were not loaded and arrangements were made to observe their vertical movements as well as that of the loaded piles. Under a load of 30 tons per loaded pile, producing an average sinking of less than 1 in., the unloaded piles, though sinking during the period of loading, rose 0.2 in. on the average after the maximum load had been maintained for a time. This indicating a practically incompressible and perfectly plastic medium, the possibility of relying upon soil compaction to carry the pier loads was considered slight. Furthermore, level readings taken over the whole area of the excavation were the basis of a calculation showing that the volume of the clay forced upward was practically equal to the volume of the driven piles.

The maximum horizontal component of the arch thrust is 80 tons per lineal foot width of pier at Piers 6 and 9. Small piers to the same bearing strata which were expected to carry the piling might have carried the vertical load of pier and arch but, supported only by the clay above described, would undoubtedly have tipped under the moment caused by the arch thrust. Greater depth and an adequate reinforcement to afford stiffness made the estimated cost excessive.

The design finally adopted is shown in plan and section in Fig. 4. By this expedient the incompressible and plastic clay is confined to such a depth that the weight of the overburden partially restores equilibrium and prevents flowing as well as providing a sufficient projected area to absorb the horizontal thrust.

Level readings on the piers before and after striking the centering of the main arches indicate that in the case of Pier 9, which has no piling in the footings, as well as in the case of Pier 6, the observed settlements were practically vertical and but a few thousandths of a foot.

The piers were filled with the earth taken from the excavations, thoroughly wet down and rammed to obtain a density of 100 lb. per cu.ft. The weight so secured was used in designing to bring the resultant thrust vector as near the transverse central vertical plane as possible. Though securing the desired object, this extreme care resulted in the formation of minute vertical cracks in the exterior walls of Piers 6 and 9, which in no way affect the stability of the piers, since the walls so cracked are not essential to the stability, serving primarily to confine the clay filling.

The careful provisions made to drain the piers proved of no value. The tile were probably displaced during the filling of the piers, or became clogged by clay being forced through the butt joints.

CENTERING — The centering for the south 140 ft. (Fig. 9) arch rests upon pine piles of 12 in. butt driven to refusal. These are uniformly 10 ft. on centers for the full width of the arch. At elev. 65 they are capped with 4x10-in. sticks extending across the arch. Sway bracing consists of 2x10-in. planks nailed to the piling.

This construction is typical, though necessarily modified for the two remaining arches on account of the track crossings. (Fig. 10.) In these instances concrete slabs were cast at the ground level, on either side of the main tracks and supported sills which in turn supported on wedges a pine sill of 14x14-in. tim-

ber. Vertical timbers of the same section and 17 ft. long rested upon these sills and carried at their tops the centering which spanned the tracks on 18-in. 70-lb. I-beams.

Referring to the typical construction, a stringer of 4x8-in. section transferred to the weight of centering and arch to the sills through oak wedges. The vertical members of the movable centering were 4x4 in. in section, capped by 6x6-in. stringers parallel to lower stringers and sills, and braced with 2x6-in. planks. The lower arch form rested upon joists of 2-in. planks 18 in. on centers cut to the exact shape of the arch and notched to fit the top stringers. The arch forms proper were 2x4-in. pieces.

As mentioned above, the contract allowed the main arches to be cast for half their width. Advantage was taken of this on the central and south lateral arches. The centering for the north lateral was raised last, and, to avoid loss of time, was built for the full width, since concreting had been practically finished on the other arches before this was poured.

As soon as the arch form was in position, the lower system of reinforcement was placed. Bars were spliced at spring stubs and intermediate points with No. 20 gage bale wire, and rested upon prisms of 1:3 mortar, 2 in. high, spaced approximately every 10 ft.. along the length of each bar. Short lengths of No. 20 wire were inserted in the prisms when they were cast and served to secure them to the bars. Bars forked at each end rested upon the lower reinforcing system and served to maintain the upper system in position.

To prevent excessive shrinkage that obtains when spans of the dimensions of these are cast in one continuous operation, the arches were broken into voussoirs of approximately 20 ft. The keys were not cast until the last concrete of the voussoirs was 10 days old. This procedure is especially necessary when the rise is small in comparison to the span, as in this instance.

The unusually close spacing of the reinforcement demanded a special method of damming the concrete at voussoir points. Bulkheads were constructed of vertical sticks of pine, 3x2 in. in section and of a length about 4 in. greater than the thickness of the arch ring. These were nailed to horizontal strips of the same section and were covered with 8-oz. canvas duck. The sticks passed between the reinforcing bars, serving to space and support them. These were removed after the concrete of the voussoirs had hardened and were used again on the second half.

The upper surfaces of the arch rings of both the main and secondary systems were kept wet by constant sprinkling for a period of two weeks.

To compensate for the settlement of the arch forms due to the weight of green concrete and to the elastic deformation of the arch on striking centers, the keys were established at varying greater heights above that desired in the finished structure. This camber or superelevation amounted to about 2 in., and on striking centers all arches settled to within ⅛ in. of the desired position.

Three weeks after the last key had been poured, every other wedge supporting the movable false work was "eased up." It is believed that this procedure in bringing a slight strain upon the concrete while in a green condition, allows the arch a period of adjustment before the final strain of complete release.

Eight cylindrical concrete specimens, 16 in. long and 8 in. in diameter, were cast from the concrete going into the keys of the east half, which were poured Aug. 14, 1911. Twenty-eight days later three were capped with truly parallel caps of plaster of paris and broken. These cylinders were left in their cast-iron molds in order to parallel as far as possible the conditions surrounding the drying of the concrete in the work. These developed a strength of 2143 lb. ± 160 lb. per sq.in.

The eastern halves of the arch rings were therefore considered to be in a condition warranting the final striking of the centers. This was done Sept. 12, 1911, the oldest concrete being in the main span and 72 days old and the greenest being in the keys of the north lateral and 29 days old.

The wedges supporting the movable falsework were of oak, 2 ft. long and tapered 1 in 12 from a maximum section of 4x10 in. In driving these out with 10-lb. sledges about 40% were broken.

Operations were commenced simultaneously on the wedges of the three

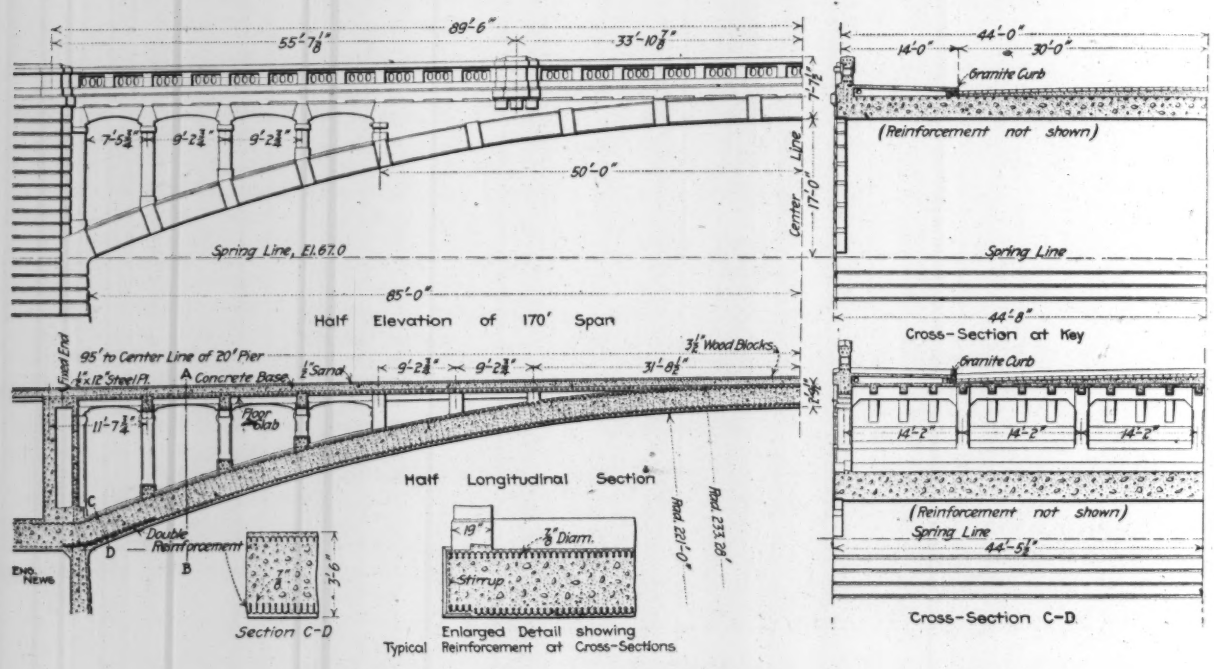


FIG. 6. DETAILS OF MAIN 170-FT. ARCH

arches, a force of 13 men being employed. The wedges were knocked loose and then replaced by hand. This procedure was followed, so that rollers might be inserted upon which the centering was to be moved to the west.

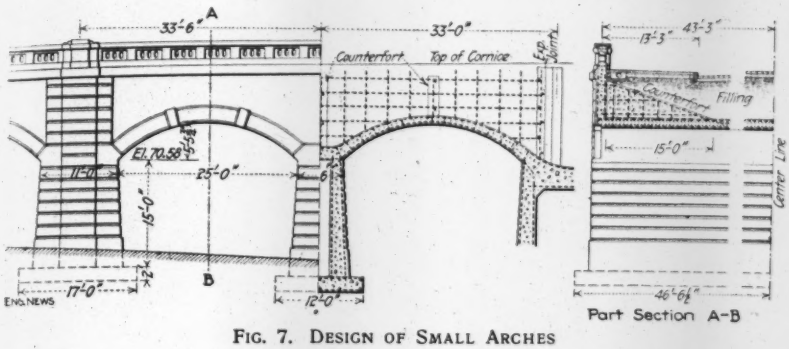


FIG. 7. DESIGN OF SMALL ARCHES

Level readings taken upon keys and footings to detect any movement. The fear that the action of the spans over one-half of the pier width might cause a rotation of Piers 6 and 9, though expressed, was not justified. A settlement of 0.001 of a foot was observed in Pier 6 at the southeast corner, and Pier 9 gave indications of a vertical downward motion of 0.012 of a foot. These displacements seemed truly normal to a horizontal plane in all cases.

The operation of striking centers occupied 3½ hours. On the following day the rollers were placed and the transference by block and tackle was accomplished in about one hour for each span.

The vertical faces of the east halves of the arches adjoining the halves about to be cast were given three coats of a heavy asphaltic cement to allow of the independent settlement of the newer halves.

Construction of the spandrel columns and floor system of the east half was commenced before centers were struck.

No especial difference was noticed in th construction of the second half. The season being well advanced by this time, the centering was kept in place for a longer period. Standard test pieces to the number of 40 were made from the concrete going into voussoirs and keys. Six of these specimens showed an ultimate strength of 1760 lb. per sq.in., 383 lb. less than the specimens made from the concrete of the east half. This was undoubtedly due to the lower average temperatures prevailing. That a similar difference exists in the moduli of elasticity seems improbable, since the key displacements were practically identical. This point would seem worthy of further investigation.

On account of the lower temperatures obtaining during the construction of the west half of the main arch system, the centering was maintained in position as long as possible. A temperature below 35° F. prevailed for several days and furnished visible evidence of the temperature length changes of concrete. Though no cracks were observed in the arches, the centering of the north 140-ft. arch was appreciably warped and the vertical posts carrying the centering of the 170-ft. arch over the tracks were forced into their mud sills about ¾ in.

MICROMETER READINGS—On the south lateral and main arch of the west half an attempt was made to estimate the unit stressing of the steel. Certain bars were marked weighed and measured and a piece 2½ in. long taken from each for a more accurate determination of the effective area. The marked bars were placed at prearranged points in the reinforcement system and drilled for gaging with an 8-in. Berry strain gage equipped with a micrometer head reading to 0.0001 in. and a telephone head receiver.

Though readings were recorded to the nearest 0.00002 in., the order of accuracy was only slightly better than 8 in 100,000, which corresponds to a unit stressing of about 300 lb. Correcting the areas of the bars by means of comparative readings between the short specimens and a turned bar of known section will give data by which the position of the center of compression may be determined with the accuracy possible under the assumption that the modulus of elasticity of the concrete does not vary from extrados to intrados. Determinations of this last value from the concrete specimens mentioned above will at least serve to establish the worth of experimental investigations of this character.

The readings taken thus far seem to indicate that while the program followed in concreting the arches, viz., voussoirs and keys, has certain advantages such as preventing cracks and making continuous concreting unnecessary, it should be modified in one of two ways. Either all bars should be lap spliced at the keys to allow for the inevitable length changes due to the drying out of the concrete, or the moisture content of the concrete should be so controlled by sprinkling or other methods that the state of strain in the exposed reinforcement of the keys would be identical in the upper and lower systems and would correspond as far as possible with that in the voussoirs.

Calculations based on the initial strain gage readings and those just previous to the casting of the keys indicate a maximum compressive stress in one case of about 10,000 lb. per sq.in. in the upper system, and a maximum tensile stress at the same point of about 300 lb. per sq.in. in the lower system, due undoubtedly to the swelling of the extrados concrete from constant sprinkling and to the slow drying out of the intrados concrete, respectively.

APPROACHES—No difficulty worthy of mention was encountered in the construction of the footings and piers of the secondary or approach arch system nor of the retaining wall of the filled approaches, though a greater depth of footings was ordered on account of the unsatisfactory soil conditions encountered at the elevation to which they were originally designed to be carried.

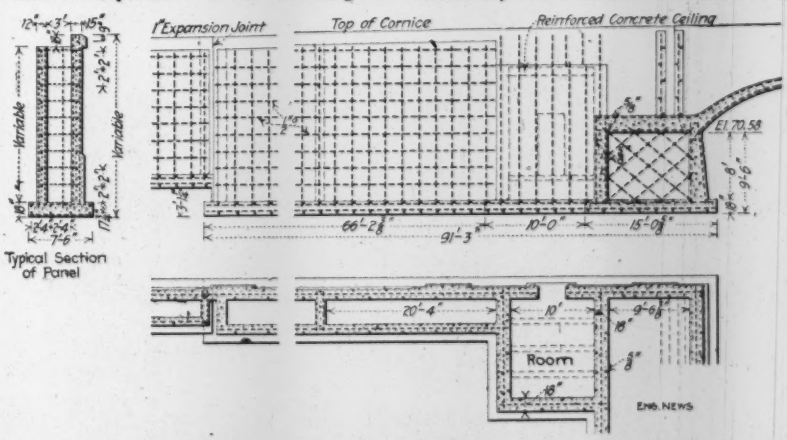


FIG. 8. DESIGN OF RETAINING WALLS OF APPROACHES

Two types of centering were used on the approach arches, viz., steel and wood. The steel centering was employed by the contractor for purely experimental reasons, the desire being to compare its economy with that of centering made on the site of the work by the carpenters.

Both types were supported at the spring by timber caps resting upon piles which were carried on the footing slabs of the various piers. In addition, the timber centerings were supported at their centers on 4x4-in. sticks resting upon mud sills at the surface of the ground. While the steel centering of a clear span might have proven more economical over water, under the conditions present in this structure the timber centering proved more economical even if the lower first cost were not considered. This was mainly due to the greater ease of handling.

The filled approach retaining walls were cast in 56-ft. sections, the distance between the label piers, at which points were located the expansion joints.

In placing the steel in these retaining walls certain horizontal bars at two closing diaphragms on the west side of the approach were accidentally left out. After the cells had been filled with clay and tamped, the inner and outer walls began to separate. The filling was removed, the walls jacked together and 1-in. bolts bearing upon iron plates were inserted and cemented in.

DECORATION—As mentioned above, the architectural treatment was maintained as near the plane of strict simplicity as possible while still maintaining an effect of attention to details and a consideration for mass and for light and shade.

Beyond the pylons at either end and the lamp posts, ornamentation has been practically eliminated. The hand railings are extremely severe. The ier surfaces have been broken by hor ontal V-shaped scorings to reduce the prominence of wind which is almost impossible to avoid in vertical surfac of large area. The day's work was ex-

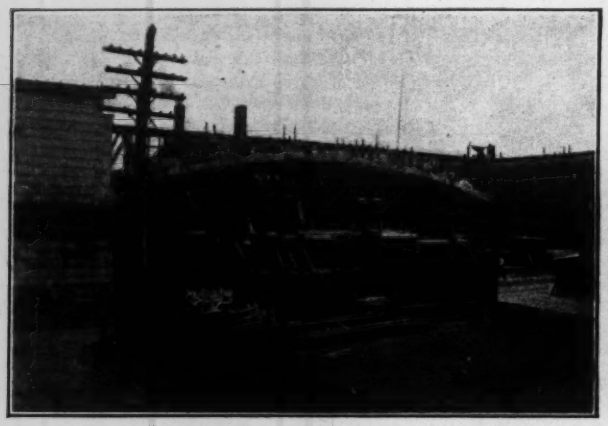


FIG. 9. 140-FT. ARCH

FIG. 10. 170-FT. ARCH

FIGS. 9-10. VIEW OF TWO ARCHES UNDER CONSTRUCTION

pected to terminate at those points, hiding to a great extent the joints so formed. Large panels and certain small details were bush-hammered. All piers, copings, hand railings and arch faces were rubbed with carborundum stones and washed with cement paste.

FIG. 11. CONCRETE DISTRIBUTION SYSTEM FOR PIER 9

CONTRACTOR'S PLANT

The contractor's main plant was situated just east of Pier 8. The blacksmith's shop and store room were located north of the concreting plant, the cement storage being adjacent and just south of this last.

Material was delivered in bottom dump cars which were switched upon a timber trestle 6 ft. above the elevation of the main tracks. The discharged material fell into various bins beneath this trestle and could be drawn at will through slides onto the feeding belt which carried the full length of those bins and up to small storage bins in the tower.

At the ground level the mixer was situated. This was a 13-ft. mixer, fed from small storage bins in the tower above. Enough material was carried in these small bins to allow of alternately filling the sand and gravel bins from the inclined belt running under the main bins.

Concrete discharged from the mixer was elevated above the level of the distributing tramways and dumped into ½-yd. side-discharge cars running on industrial tracks.

The main tramway was located on the east of the viaduct and at the elevation of the spring. This extended to the end of the south approach and northward to Swan Ave. All footing and much of the retaining-wall concrete was deposited from this and its temporary extensions.

A second plant, consisting of a 10-ft. mixer and tower, was located at Swan Ave. at the north and served this section of the work.

An experimental secondary hoisting tower was erected at Pier 9, from which the concrete for this pier was deposited through a system of chutes and a central hopper. It is understood that this was not practical nor economical.

When the elevation of the construction reached the horizontal pier diaghragms, a second system of tramways was erected at an elevation allowing the balance of concrete to be deposited directly from the cars. All arch-ring concrete was transported on this system.

Hand railing of the approaches was cast in sections on the ground. Railing over the arches was cast on the floor system adjoining. After adequate hardening, the sections were hoisted into place by derrick and lined up between the posts cast in place over the label piers and similar architectural points. They were then capped in place.

PERSONNEL

The designing and direction were carried out in the Bridge Division of Street Department, J. C. Travilla, Commissioner; O. W. Childs was Bridge Engineer during the design and construction of the main part of the work; A. C. Janni is responsible not only for the design and calculation, but also for the changed footing scheme, minor changes and details and also for the direction and inspection of work during construction. The decorative treatment of the structure was at first attempted in the office of the City Bridge Engineer, but was later turned over to Prof. A. L. Mann, of Washington University, as Consulting Architect, and the main decorative treatment is due to him. The W. P. Carmichael Construction Co. was the contractor. The author desires to express his thanks to Mr. Janni for invaluable aid and suggestions during the writing of this article.

Electric Furnace Steel for Rails

The Electric Furnace as a Means of Producing Improved Steel

BY W. R. WALKER*

One session of the recent meeting of the American Iron and Steel Institute was largely given up to a discussion of electric-furnace steel for railways. The most important paper was by W. K. Walker, a chemist whose life has been largely spent in the steel industry and who is now in charge of the development of metallurgical processes for the U. S. Steel Corporation. The most important discussion was by P. W. Robinson, Vice-President of the Illinois Steel Co. Their remarks are reprinted in part here.

In the manufacture of steel by either the bessemer or openhearth process, it is very difficult to remove the last traces of oxygen. In the basic bessemer process, the overblown metal, which is an extreme case of oxidation, contains only 0.06% oxygen. Oxygen in combination with carbon (carbon monoxide), silicon, iron, aluminum and manganese, and also the combinations of silicates with these oxides, are very deleterious in steel.

My investigations lead me to believe that in the manufacture of steel for the so called heavy products and steel that is produced in large quantities, a combination of either the acid or basic bessemer converter, and the electric furnace will take a very prominent place. With this combination it is possible to produce steel extremely low in oxygen and other impurities at a cost that will not be prohibitive.

At the present time there are over 70 electric furnaces of various types producing electric steel in Europe and America. These range in capacity from 1 to 15 tons. There is now under construction in Germany a furnace of 25 tons capacity. A number of these furnaces are competing successfully with crucibles in the manufacture of very high grade steel.

Generally speaking, electric furnaces may be divided into two groups: (1) induction furnaces, in which the heat is supplied by a current induced in the bath; (2) arc furnaces, in which the arc is struck, either between an electrode and the metal in the bath, or between two or more electrodes so as to heat the metal only by radiation from the arc.

*Assistant to the President, U. S. Steel Corporation, 71 Broadway, New York City.

In operating the electric furnace at the present time, the most prominent methods or combinations are as follows:

(1) Oxidation of silicon, carbon and manganese in an acid-lined bessemer converter and removing the phosphorus in the basic-lined electric furnace with an oxidizing slag and then recarburizing and with the aid of manganese and carbon and a new reducing slag removing oxygen and sulphur and dead melting as in the crucible process.

(2) Removal of silicon, carbon, manganese and phosphorus in a basic-lined bessemer converter and further removing phosphorus (if desired) in the basic-lined electric furnace with an oxidizing slag, and then with the aid of manganese and carbon and a new reducing slag removing oxygen and sulphur and dead melting as in the crucible process.

(3) Removal of silicon, carbon, manganese and phosphorus in the basic openhearth furnace and then recarburizing and in the basic-lined electric furnace with the aid of manganese and carbon and a new reducing slag removing oxygen and sulphur and dead melting as in the crucible process.

(4) Melting of cold scrap of inferior quality in a basic-lined electric furnace; removing phosphorus with an oxidizing slag and then recarburizing and with the aid of manganese and carbon and with a new reducing slag removing oxygen and sulphur and dead melting as in the crucible process.

(5) Melting high-grade materials in the electric furnace and dead melting as in the crucible process.

The phosphorus is removed in the basic electric furnace in the same manner as in the basic openhearth furnace—that is, by the use of lime and oxide of iron —and the resulting slag containing the phosphorus is removed and a new slag formed consisting of burnt lime and fluor spar; when the slag is melted, coke dust is added, which, coming in contact with the lime in the slag and the electric arc, produces carbide of calcium. The free carbon and possibly the carbide of calcium in the slag, with the aid of carbon and manganese in the bath, eliminate the oxygen from the steel.

As compared with the bessemer and basic openhearth process, the electric has the following advantages: (1) The more complete removal of oxygen; (2) the absence of oxides caused by the additions, such as silicon, manganese, etc.; (3) the production of electric-steel ingots of eight tons in weight and smaller that are practically free from segregation; (4) reduction of sulphur to 0.005%, if desired; (5) reduction of phosphorus to 0.005%, as in the basic openhearth process, but with the complete removal of oxygen.

As evidence of the reducing properties of the slag in the basic electric furnace, it has been found that if oxide of manganese and oxide of iron are thrown on the molten slag, the oxides are reduced to the metallic state and the reduced metal goes into the bath. Blown metal from the acid bessemer converter, containing only 0.10% to 0.20% manganese, has been completely deoxidized in the electric furnace without addition of manganese or

aluminum, the usual amount of silicon being added in the steel ladle. Rails made from this steel are now in service. The composition of one heat of this steel is as follows:

	Per Cent.
Carbon	0.55
Manganese	0.13
Sulphur	0.017
Silicon	0.19
Phosphorus	0.022

These rails are comparatively soft, but are showing superior wearing qualities compared with the bessemer rails in the same track and under the same service conditions.

Electric-steel ingots crack much less in rolling than either bessemer or basic openhearth steel. Cold electric-steel ingots when heated and rolled into rails, roll extremely well.

At the present time there are approximately 5600 tons of standard electric-steel rails in service in the United States. These rails have been in the track about two years. During the past winter some of these rails have been subjected to very low temperatures—in some cases as low as −52° F., and are being exposed to all possible conditions of severe service. It is too early to state much about the wearing qualities of these rails, but from present indications it would appear that rails made by the basic electric process can be made somewhat softer than by either the bessemer or basic openhearth process and still show highly satisfactory wearing qualities. Up to the present time we have not heard of any basic electric rails in use in this country being broken in service.

For experimental purposes, I have had made a small tonnage of electric-steel rails, which have varied in analysis as follows:

	Per Cent.
Carbon	0.50 to 0.75
Manganese	0.13 to 0.80
Silicon	0.10 to 0.40
Phosphorus	0.02 to 0.06

On account of the wide variation in the chemical composition of this steel, it would be difficult, without going into considerable detail, to discuss the physical properties of these rails. It might be stated, however, that electric steel of a given tensile strength has a slightly greater amount of elongation than basic openhearth steel and that electric steel is somewhat denser than basic openhearth or bessemer steel.

With the electric furnace, it is possible to produce steel, which when magnified one thousand diameters, shows no oxides or slag inclosures.

As high-grade electric steel can be produced at a lower cost than crucible steel, there has been a gradual increase in the production of electric steel for certain purposes where crucible steel was formerly employed and where it has been demonstrated electric steel can be successfully used. This increased production has not been so marked where the object has been the improvement of steel entering into products manufactured in large quantities where the expense involved for experimental work is very great and where of necessity it takes several years to demonstrate if rails and other products made by the electric process are superior to those made by either the bessemer or openhearth process. From present indications, it would seem probable that there will be a decided increase in the production of electric steel for these products in the near future.

Electric Furnace Experience at South Chicago

By T. W. Robinson*

Three years ago the 15-ton. basic-lined Heroult furnace erected at the South Chicago works of the Illinois Steel Co. made its first heat. It was then the largest electric furnace in existence and as yet none of greater capacity has been put into actual operation, although there are a few 20- to 25-ton furnaces under construction in Europe.

Our purpose was to demonstrate whether it was feasible to successfully operate a large electric furnace and make electric steel in large tonnages. At the time the South Chicago furnace was started, the electric furnaces used in the manufacture of steel here and abroad were small, running from a ton or less to five tons in capacity. The aim abroad was largely to find a process cheaper than the crucible. Our aim was to command a superior steel, and if possible at a cost that would permit of its use in such products as rails.

Our mechanical, metallurgical and other problems proved many, and our experience soon demonstrated that the conditions surrounding the successful operation of a large electric furnace were in many respects entirely different from those involved in the use of smaller units. For example, the demands of a 15-ton electric furnace proved to be far in advance of the art of manufacturing electrodes. Our necessities represented a requirement that the electrode manufacturers of America and Europe had not been called upon to meet, and it took much time and money before there was finally secured the 20-in. round amorphous carbon electrode now being used.

While in the application of the electric furnace to the metallurgy of steel there is usually embodied the preliminary removal of impurities by oxidation, the thermal and chemical conditions that obtain are unusually favorable to the final purification of the metal. Although it has proved perfectly feasible to make steel of superior quality from even low-grade cold material, the usual practice at South Chicago is to refine in the electric furnace full-blown metal from the bessemer converter.

While the electric furnace at South Chicago has probably operated on a greater variety of products than any other furnace in the world, especial attention has been given to the production of electric steel for rails. The results have been most promising.

The steel, in teeming, lies much more quietly than is ordinarily the case with openhearth or bessemer. The ingots when split show a very solid metal, with a remarkable freedom from blowholes. The pipe, unless filled, is as deep as with openhearth or bessemer steel. Segregation is at a minimum, and the steel is exceptionally homogeneous. Chemically speaking, almost any result within reasonable limits can be obtained. Physically, the metal is more dense than either openhearth or bessemer. In its ultimate strength and elongation for the same carbon, there is but little difference between electric and openhearth steel in the higher carbons. In the lower carbons, electric steel has a tendency to a higher tensile strength and a possibly somewhat lower elongation.

Many etched sections of rails indicate that the steel from the electric furnace is peculiarly uniform in structure, and it appears to be exceptionally free from oxide and slag inclosures as partially determined by microscopic examination. In fact, such superiority as electric steel may have, probably largely lies in its relative freedom from oxygen.

How much there may be in the theory advanced by some that the characteristics of electric steel are partially due to the influence of the peculiar thermal conditions upon its molecular structure, I cannot say. Certain indications, however, point to there being more in this hypothesis than is generally recognized.

We have, thus far, received no report of any breakage from the 5600 tons of standard rails that we have shipped. Some of these rails have been in track for two and a half years or more. Some of the first rails that we produced were intentionally made upon the soft side, running as low as 0.55% in carbon. Our later electric rails, of which the laboratory results would indicate a relatively better wearing quality, have been made ten or more points higher in carbon.

On account of the comparatively short time that the electric rail has been in service, any statement in respect to its comparative quality is open to question. Of course, the final verdict on the merits of any steel must be in that metallurgical court of last resort—result in service. But whatever may be the verdict, American steel practice and the public must be the gainers from the extensive work that has been done in the endeavor to produce, through the electric furnace, a rail of superior quality.

*Illinois Steel Co., South Chicago, Ill.

Letters to the Editor

Safe Dam Construction in New York

Sir—Your editorial in your issue of June 7 on the design of small dams is interesting. The Conservation Law was passed in order that the people living down-stream from dams might have the protection of the state. This protection the Conservation Commission is exercising every effort to give them. You are entirely correct in emphasizing the absence of competent design and inspection which has characterized these structures in the past. We are trying to correct this bad state of affairs by requiring the owner to submit plans and specifications which warrant our approval before he may begin the work of construction.

In order that we may have knowledge of projected dams we have notified the Supervisor of every town in the state of the provisions of the law. Our game protectors, forest rangers and fire wardens are all ordered to report to this Commission the beginning of any structure in any stream of the state. In addition to this, the newspapers of the entire state are carefully searched for items of this nature. The Commission started out nearly a year ago on the theory that no insecure dam shall be built in the State of New York if it is possible to prevent it.

Existing dams, especially the older ones, are a more difficult problem; but our principal anxiety comes not from the timber dams, so numerous in the northern counties, but from the so called concrete dams, which, as you state, have been erected regardless of theory or practice.

CONSERVATION COMMISSION,
BY JOHN D. MOORE,
Commissioner.

Albany, June 13, 1912.

More Primitive Ferryboats

Sir—The article by C. E. Chappell on "A Ferryboat Propelled by the Current," in your issue of May 30, 1912, was especially interesting to the writer because his grandfather operated a ferry of this type over the Cedar River, in Iowa, some 40 to 60 years ago. In this older form the ferry was attached by means of a trolley or sheave to a cable supported on short towers on the banks, the ferry crossing the stream on a line parallel to the cable instead of in the arc of a circle as in the Clarksville ferry. The method of changing the angle of the boat to the current was the same. It had the advantage of a lower cost of construction and the possibility of placing the ferry landing wherever desired with less difficulty. Of course, it could not be used on a navigable stream.

Another type of ferry which would seem to fulfill the conditions of good engineering practice given, viz., "the art of directing the great sources of power in Nature to the use and convenience of man" is one used in the Philippines. The equipment consists of a bamboo raft, a "carabao" or water buffalo (*bos bubalus*) and a Filipino. The motive power, the carabao, is "direct connected" to the raft by means of his tail and a strong pair of arms belonging to the Filipino who sits on the edge of the raft. When the raft is loaded the carabao strikes out for the opposite shore of the stream.

R. C. HARDMAN.
Fort Huachuca, Ariz., June 10, 1912.

The Defense of Mr. C. G. Elliott

Sir—Much space has been given to letters and editorials in connection with the dismissal of C. G. Elliott from the office of Chief of Drainage Investigations. It seems to me that the tone of these letters and resolutions is wrong, and that if instead of demanding that he be exonerated they would put the demand in the form of a petition for a complete investigation, it would be much more apt to receive recognition.

W. C. HAMMATT.
Room 802, Hearst Bldg.,
San Francisco, Calif., June 12, 1912.

[An investigation has just been concluded by the House Committee on Expenditures in the Department of Agriculture, of which Hon. Ralph W. Moss is Chairman. While all the matters in connection with the case have not been taken up, the investigation has proceeded far enough to bring out testimony showing conclusively Mr. Elliott's innocence of any wrongdoing.—ED.]

Anti-Creeping Devices for Railway Track

Sir—Can you oblige me with information as to an efficient device for stopping the creeping of rails in railway track? I have a place where the creep has extended to 5 ft.; but only one rail moves, the other remaining stationary. I hear there is a device used in America which consists of a pair of loose fish-plates; this permits the rail to expand and contract due to changes of temperature, but when a load comes on the joint the fish-plates, or splice bars, grip the rail tightly. In this case the rail is anchored at the middle to a tie. This device seems to be correct in principle. I do not think any device fixing the rail at the joint or depending on the ties for anchorage would meet the conditions of the particular place mentioned.

C. B. BARRIE,
Executive Engineer, Northwestern Ry.
Bhatinda, India.

[Present practice in this country is to rely mainly upon devices which grip the rail tightly and bear against the sides of the ties, the number of devices per rail depending upon the severity of the conditions of creeping. In this way the ties and the mass of ballast between them serve as a horizontal anchorage to resist any tendency of the rail to creep. Where the pressure is severe, blocks may be fitted tightly between the ties, near their ends. In some forms, the anti-creeper or anchor is secured to the rail flange by a bolted clamp. The tendency is to avoid bolts, however, as the clamp is likely to work loose. In the more commonly used anchors, the anchor is held securely upon the rail flange by a taper key or wedge, or by a cam action obtained by fitting the anchor slightly diagonal to the line of rail, so that any longitudinal pressure of the rail only makes the jaws grip the flange more tightly. The lower part of the device, of course, bears against the side of the tie.

A device of a different type and less extensively used is a tie-plate designed to grip the rail base. In one form, the tie-plate has at one side of the rail seat a shoulder against which the rail base or flange fits, and at the other side is a hole for a wedge-shaped spike, which bears against the opposite side of the flange. It is claimed that by driving down these wedges the rail is gripped so tightly (at each tie) that it cannot slip longitudinally. The wedge-spike is independent of and additional to the ordinary spikes for securing the rail to the tie.

In an older type of anchor, two short pieces of angle bar are secured to the middle of each rail with a single bolt, and are spiked to the tie; the spike fits a notch or hole in the flange of the bar and thus receives any end thrust from the rail. But extra bolt holes in the rail are objectionable, and if the spike works loose in the tie the rail may shift. With the rail anchored at the middle, it is free to expand and contract toward either end, assuming that a proper joint spacing is maintained. This avoids the cumulative

effect of rails crowding against one another in a certain direction. An early practice was to drive spikes in notches in the splice bars or against the ends of the bars to resist creeping, but this is objectionable and is far less effective than holding the rail at a point (or points) between the joints.

With the general increase in wheel loads and traffic, disproportionate to the strengthening of the track structure, the creeping of track becomes increasingly evident. That this is the case is indicated by the very extensive use of rail anchors, which are now almost as common a form of track appliance as tie-plates and joint devices. Several rail-anchors are on the market and they are used in very large quantities, since their cost is well warranted by the improvement in the track conditions, and the saving of time and expense in maintaining track or restoring it to its proper conditions. In addition to preventing creeping on open track they prevent the movement at switches, grade crossings, etc., where such movement would cause considerable distortion of the track.

In very exceptional cases, where the longitudinal pressure is such as to make it impracticable or undesirable to attempt to resist it or to hold the rails (since this might result in buckling and distorting the track), a device is used resembling a split switch. The point or taper rail forms the end of the fixed rail, so that the creeping rail approaches it. The end of the creeping rail is laid against the outer side of the taper rail, but not fastened to it, so that it can move freely. For security the taper rail is attached to a plate on the ties and is bolted to a guard rail on the inside of the track, leaving a throat or passage for the flanges of wheels.—EDITOR.]

Can an Impermeable Core be Used in Mississippi Levees?

Sir—The editorial in your issue of May 23, under the heading "What is the remedy for Mississippi Floods?" will be of interest to all your readers who live behind the Mississippi levees. More especially will this be the case, because the subject of the levees themselves is so seldom discussed in the engineering journals.

Your conclusion that earth embankments are the only kind to be considered in the attempt to restrain the Mississippi, will probably be concurred in by all who have experience in building and maintaining these dikes.

It is not impossible, however, that a correct engineering solution of the problem will call for the use in a small way, of some other material in conjunction with the earth embankments.

Any man of common sense can build a levee large enough and high enough to hold the flood if he is given unlimited means, but the engineer, in this as in other work, must not use more material or create greater expense than is necessary to properly insure the purpose of the work.

The earth levees as now existing are in some places wonderfully assuring and in other places woefully fear inspiring.

For some years the writer had charge of a line of levees in southern Louisiana. Included in this line were stretches of levees whose sections were very meager and whose crowns were only wide enough for a foot path. In addition certain of these stretches had to be raised 2 ft. in flood time. Despite these untoward conditions, these levees presented no appearance of probable failure, and caused no concern whatever. Their appearance of safety and their freedom from failure arose from the fact that no water seeped through from the river. They remained dry.

Also included in the line were stretches of levees whose sections accorded more with modern practice. Their crowns were well above high water and were 6 to 8 ft. broad. Although these latter levees were subject to no greater head than the former, some of them caused the greatest concern to the whole community. Their weakness arose from the fact that they became soaked from water which seeped through from the river, with the result that there was constant danger of sloughing. Anyone who has had charge of levees in high water could cite instances exactly similar to the above.

The point to be observed is that if the levees can be kept from becoming soaked by seepage, a surprisingly small section will withstand the pressure of the water. Seepage occurs from several causes. At times the earth which must be used is of a class that is more than normally permeable. In such cases it is of the highest importance that that method of construction be used which will best compact the material. Sometimes when a previously existing levee is raised and enlarged, the new work is not properly joined to the old, and the seepage takes place at the level of the original crown. Any carelessness in construction naturally makes seepage likely.

There are two other causes of water passing through and under the levees which are serious, and these seem to call for the assistance of some other material than earth. Frequently water passes entirely under the levees and bursts out at quite a distance in the rear.

The writer does not know for certain the cause or causes of these phenomena, but the frequency with which such cases have been reported in the present flood and their extreme danger call for particular consideration. Erosion and soaking occur whenever these channels are found. There can be no objection to a wall of impermeable material being placed in the foundation of a levee, and as it would be perfectly support[ed] against overturning it need be of on[ly] sufficient thickness to prevent the flo[w] of water. It does not appear that th[is] should add but a small percentage to t[he] present cost. If the foundation be ma[de] positively impermeable, certainly a goo[d] beginning has been secured.

Another serious element in soaking a levee is the action of crawfish. These troublesome crustaceans are very numerous in some localities. They bore from one side of the levee to the other and allow the water to flow through. At first the hole is small and not dangerous. In all cases, however, such holes constitute a menace to the dryness of the levee, and in many cases where the soil is light, erosion takes place quite rapidly. Levees frequently become honeycombed with these holes and it is impossible to keep such a levee dry. As crawfish will bore through any earth, is it not possible that some other material may be advantageously used to prevent their entrance into the levees or their foundations? Levees are also subject to attacks from muskrats. These enter on the river side below the surface of the water. Unlike the crawfish they do not bore all the way through. Usually there is no indication of their presence until they have hollowed out a home, which causes a sudden cave-in of the crown of the levee.

It is not the purpose of this letter to point out all the danger to which levees are subject, but only to call special attention to the importance of the dryness factor (to borrow a steam engineering term). No one objects to a levee of huge section in front of his property, but as we have not the money to purchase these desirable luxuries is it not next best to consider how we can protect our smaller levees, which we can afford, from those elements of danger which tend to destroy their strength by allowing them to become soaked.

The writer does not believe that any dry levee ever blew out or toppled over for lack of section. The earth levee is our logical protector, but the earth levees need a little protection themselves.

J. C. MORRIS.
723 Audubon Bldg., New Orleans,
June 5, 1912.

Notes and Queries

Attention has been called to a statement in the article "A Combined Coal Dock Elevator and Crusher," in our issue of May 23, page 975, that the machinery was designed and installed by the Link-Belt Co., of Philadelphia. It now appears that the coal-unloading machinery, including the direct-acting hoisting and trolley engine, grab bucket, trolley, one-man control, and the parts connected with the apparatus for taking coal from the boats and delivering to the weighing and conveying apparatus described were designed and installed by the Mead-Morrison Mfg. Co., of Cambridge, Mass.

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Contents

*Unit Wall Concrete Building Construction, Fort Crockett, Texas; R. C. Hardman..... 1205
A Summary of Eight Years' Work on the Panama Canal..... 1206
*The Canadian Transcontinental Railway 1208
The Improvement of the Neponset River in Massachusetts..... 1217
*Water Purification at Minneapolis; J. Arthur Jensen..... 1218
*Closing a Spouting Oil Well..... 1225
*Kingshighway Viaduct, St. Louis, Mo.; Mont Schuyler..... 1226
Electric-Furnace Steel for Rails... 1233
LETTERS TO THE EDITOR..... 1235
Safe Dam Construction in New York; John D. Moore—More Primitive Ferryboats; R. C. Hardman—The Defense of Mr. C. G. Elliott; W. C. Hammatt—Anti-Creeping Devices for Railway Track; C. B. Barrie—Can an Impermeable Core Be Used in Mississippi Levees?; J. C. Morris—Notes and Queries.
EDITORIAL 1237
The Largest Engineering Organization in the World—Specifications for Railway Maps—Concerning the Difference in Concrete—Steel Rails Rolled from Electric-Furnace Steel — Proving That Forests Benefit Navigation.
Annual Convention of the National Electric Light Association..... 1240
Annual Convention of the American Railway Master Mechanics' Association 1245
Present Status of Mechanical Stokers for Locomotives..... 1247
The Maintenance of Superheater Locomotives 1249
*Standard Railway-Crossing Signs for New Jersey..... 1251
Comparative Tests of Metropolitan Pavements; New York City..... 1251
*The Reconnaissance Survey for the Denver & Rio Grande R.R.: Recollections of an Old-Time Engineer; Augustine W. Wright.... 1252
ENGINEERING NEWS OF THE WEEK 1254
PERSONALS 1255
ENGINEERING SOCIETIES..... 1256

*Illustrated.

Engineering News

It will be noted in our news columns that another examination is soon to be held for the commissions in the Engineer Corps of the United States Army to be filled by civilian appointments. Although there is only a little more than two months available for the complicated procedure of qualifying for these examinations, we trust that they will be better attended than the one last winter when only four candidates presented themselves. It was apparently with considerable reluctance that the authorities initiated this method of filling up the hitherto most restricted branch of the Army, and what promises to be a most desirable opening for technical graduates is apt to be closed if more interest is not taken in the examinations.

Specifications for Railway Maps

The California State Railroad Commission has issued specifications for the preparation of the maps of railway lines which are required to be filed with the Commission by all the railways of the state. From information received from various sources it appears that some of the railway companies find great difficulty in complying with the specifications. It is required, for example, that the names of owners of adjacent and abutting lands from whom deeds or titles were obtained, shall be placed upon the map. At bridges and culverts there must be shown the depth of penetration of piling, trestle and bridge foundations and the footings of masonry piers, culverts, etc. On each mile of railway is to be shown the following construction quantities, clearing, grubbing, total excavation with classification, total embankment, overhaul, classified trestle timber, trestle piling, culvert masonry with classes, bridge masonry with classes, quantities of excavation and embankment with classification on each cut and fill, etc.

The object of these and similar requirements of the specifications is for the prospective appraisal of the railways of the state. Probably some of the railways, constructed within recent years and those which have most carefully preserved their records will be able to comply with these specifications. There are on the other hand many small railway companies and in the older states of the Union many railway systems which have been formed by the consolidation of small lines where it would be absolutely impossible to give the information here called for. The records which would furnish it have long ago been burned, lost or destroyed, and in many instances the numerous changes which have taken place since original construction would make such records of no value whatever even if they could be secured.

The specifications would seem to have been drafted largely on the basis of asking for everything which might be of any use whatever. A better and fairer basis would seem to be to require only what can reasonably be furnished. It does no good but rather harm to ask for impossibilities.

The Largest Engineering Organization in the World

The extension of New York's rapid-transit subway system, which is about to be undertaken on a large scale, will involve an investment greater than that presented in any engineering undertaking now in progress in the world or which has ever been undertaken with the sole exception of the Panama Canal. Naturally a very large force of engineers will be required to carry out this great work. While the details of construction are comparatively simple when once the general designs are settled upon, it is needless to say to our readers that there is a vast amount of work in the way of supervision, inspection, instrument work and no little engineering skill of a high order required in connection with the many collateral improvements such as the handling of sewerage, water and other street services during construction, guarding the public safety, working out the details of operating systems, rolling stock, etc. To carry out this work, the New York Public Service Commission is to make a very large addition to its engineering staff. Something like 136 engineers, we understand, are to be appointed at an early date to positions in the organization. The appointments are to be made under the Civil Service law which gives preference to citizens of the State of New York, although others are eligible. It is stated that when the organization is completed, it will have the largest number of engineers in its service of any organization in the world, which is what would be expected in view of the enormous investment to be made of which every detail is to be under engineering direction.

Concerning the Difference in Concrete

There is concrete and concrete! That is a fact which should be clearly understood by every engineer whenever the subject of concrete is under discussion. We have been especially impressed recently with the contrast between the quality of the average concrete, such as

one sees mixed and placed by the average small contractor and many large concontractors as well; such concrete as one often sees which, after having stood a few years, shows more or less places where defective finish, disintegration and cracking are apparent—the contrast, we say, between such average concrete and the concrete which is being made on some engineering works of large size, where such concrete as an engineer describes in his specifications is actually produced.

Two notable examples of such ideal concrete work are the Panama Canal locks and the great dam, power house and lock of the Mississippi Power Co., now under construction at Keokuk, Ia.

In making concrete on these works, good stone, good cement and good sand are assembled and a *measured* quantity of each is deposited in a large batch mixer and thoroughly mixed, with enough water to make a sloppy mass in which air bubbles will inevitably rise to the top. The mixed concrete is then taken in large buckets and deposited inside substantial forms. The work goes on so rapidly that the form is filled to a considerable depth before setting begins.

It is probable that one of the chief reasons for the remarkable excellence of concrete made in this way is the fact that the soft concrete is put under a heavy hydrostatic pressure before setting begins and is thus made far more dense than was ever possible under the old practice when a dry mix for concrete and thorough ramming were universally specified by engineers.

We commented on the same thing some years ago in these columns in connection with the remarkably solid concrete produced by laying concrete under water with a tremie on the Detroit tunnel work. The heavy pressure on the concrete, which was there delivered from a very high tremie, produced a far more dense and solid concrete on that work than is obtained in nine-tenths of the work laid in the open air.

It is commonly said nowadays that at present prices cement is the cheapest reinforcement one can use in concrete. It may be added that another cheap way to reinforce concrete is to mix and place it in the best possible manner. It is an object lesson in concrete work to any engineer to examine the completed portions of the Mississippi River dam and power house at Keokuk and note the solidity of the concrete, the absence of air holes, temperature cracks and crazing, the even finish of the exposed surfaces and the density where it has been broken into by way of test.

Of course, it is well understood that a perfection is possible in the concrete work on these huge structures which is out of the question on any ordinary concrete job; but certainly the way average concrete is laid leaves large possibilities for improvement. Take the average concrete laid on street or foundation work; and whatever the engineer's specification may call for, this is what one commonly finds: For materials, whatever sand and stone or gravel the locality will furnish cheapest, with ashes—called by courtesy cinders—introduced as a variant. The ingredients are measured by counting the number of shovelfuls thrown into a heap; and if Tony loses count, stop when the batch looks about right. Hand mix it by shoveling the pile over and over—hard back-breaking work. The engineer himself would slight the mixing if he had to furnish the muscle. The mix is shy of water, and has to be in order to permit shovel mixing; and even at that more or less cement flows off on the street surface or seeps through the cracks in the mixing platform. To save it, more or less street dirt is scraped up and goes along into the mix.

By skilful use of mortar and trowel, concrete made in this way is given a fine surface finish and made to look like an excellent job; but the body of the concrete is of very variable composition and strength and the weak places yield under the influence of percolating water, ice formation, stresses and general wear and tear.

It is very difficult to make the average small contractor or concrete workman take the pains to make high-class concrete; for he has found by experience that making it with any old materials any old way produces results which so far as he can see are good enough. In city work particularly, it is hard for an engineer to make a contractor do his work in the best way, for the latter is apt to be held in high esteem by the city councilmen as a "practical" man, while the refinements the engineer desires to obtain are looked upon as useless, theoretical, hair-splitting. Often it is not until the engineer can point to curbs battered to pieces, sidewalks cracked and retaining walls weeping at the courses or bulging from weak forms that he can secure the enforcement of his specifications to the letter.

There is a scarcity, without doubt, of concrete contractors who will execute work in the most thorough manner and of concrete workmen who will give conscientious care to their tasks. But given such contractors and such workmen, achievements are possible in concrete work which many engineers hesitate under present conditions to undertake.

Steel Rails Rolled from Electric Furnace Steel

The opinion is not uncommon, even among engineers, that the electric furnace for melting and refining steel has failed to achieve any large commercial success. To those holding such an opinion, Mr. Walker's paper in this issue will be surprising. It shows that the United States Steel Corporation has rolled from large electric-furnace ingots, 5600 tons, or over 30 miles, of steel rails, and that the corporation is able to satisfy any moderate demand for rails of this special quality for trial.

This progress has been made quietly, while the partisan adherents of the arc and induction types of metallurgical furnaces have been belaboring each other and distracting general attention from the actual commercial development. The electric-furnace situation in some aspects is like the controversy between the respective adherents of alternating current and direct current for railway operation; but this latter controversy has fortunately passed its crisis, with the realization that each system has its place.

Examining the status of the electric furnace for iron and steel work, further than noted in Mr. Walker's paper, it may be seen that little progress has been made in the direct reduction of iron ore by electric current. Some very promising large-scale work is being continued at Trollhättan in Sweden,* and Heroult in California, the product of these plants, though not of large tonnage, being marketed more or less regularly. It should be noted that the first plant is in a country where hydroelectric power is being very cheaply developed, and that the second plant is in a district where cost of transportation has raised the price of pig iron to some $21 or $22. Without some such favoring conditions intervening, it must be expected that in ore reduction we cannot afford the great cost of electric heating.

In refining steel, however, such special needs are met that the electric furnace seems to be firmly established for the production of the higher grades of special steels. As might be expected, the electric-refining furnace has not yet been able to compete in cost with the bessemer and openhearth where a cheap or medium grade of material with moderate amounts of phosphorus and sulphur is permissible.

Abroad, the development of electric-steel furnaces seems to have consisted largely of efforts to evolve a process cheaper than the crucible—cheaper than the openhearth. In this country the aim seems to have been to secure high quality of product. Taking advantage of the possibility of carrying very pure raw materials through the alloying process without contamination by flue gases, and the opportunity of working out completely the reactions between bath, hearth and slag, it seems possible to produce every form of iron or its alloys in great perfection of quality. The cost of the process ranges upward with the degree of purity attained. For the best grades the cost, while greater than under the older processes, is not prohibitory.

*See Engineering News, Jan. 11, 1912.

Proving that Forests Benefit Navigation

ENGINEERING NEWS has always been in hearty sympathy with the projects to create national forest reservations in the high mountain regions of the Southern Appalachians and the White Mountains of New Hampshire. When Congress, some two years ago, gave its sanction to this project and provided the sinews of war to permit it to be carried out, it stipulated that before any land should be purchased the U. S. Geological Survey must certify that the creation or preservation of forests in the region was of benefit to the navigation of rivers having tributaries flowing therefrom.

We need hardly say in this place that such a law is absurd on its face. The actual amount of traffic on any of the rivers which draw any considerable proportion of their waters from these mountain regions is so trifling as to be a joke. In the second place engineers fully understand, as a broad, practical question, that whatever the merits of forest preservation in itself, its effect upon the flood flow of streams is too variable to be of practical importance. Nevertheless, Congress in its wisdom—or lack of wisdom—decided that it was a pre-requisite in order that the federal government should have constitutional authority to undertake this work that it should be shown to have some practical connection with navigation in order to come under the interstate commerce clause of the constitution. The Geological Survey, therefore, had laid upon it the task of finding a way to show with scientific truthfulness that forest preservation on these mountain slopes did have a measurable influence on navigation.

In the Southern Appalachian Mountains the problem was solved by bringing in the matter of erosion. The Survey has certified that on tracts aggregating nearly 2,000,000 acres in extent, the navigability of streams flowing from the tracts is affected by the excessive erosion which follows deforestation, which erosion chokes the rivers with the deposits washed down from the hills.

In the White Mountain region, however, this claim could not truthfully be made. Even at high flood the streams flowing off the White Mountain slopes carry very little sediment. It was up to the Survey, therefore, to find some different method of proving that the White Mountain forest reserve was justifiable under the congressional statute. On the other hand, the Survey had before it the exhaustive investigation made by Colonel Burr of the Corps of Engineers,* in which, by records of river gagings extending back for a long period of years, it was shown that no substantial change had taken place in the run-off from the Merrimac River watershed, notwithstanding the great changes in growth and removal of forests on the watershed which have taken place during that time.

The manner in which the Survey has finally solved this difficult problem and has proved the necessity of the White Mountain forest reserve to protect navigation in the Merrimac and Connecticut, the only two navigable rivers flowing from this region, is recorded as follows in a bulletin just issued by the Survey:

> That the forest cover of the White Mountain area has a distinct and measurable effect upon the navigable streams which head in that region is the unequivocal and emphatic statement of the United States Geological Survey.
>
> The report of the Geological Survey is based on the results of exhaustive investigations and specific field tests which have been carried on during the past year. The investigations are believed indeed to definitely solve a problem that has long been a source of strenuous contention among scientists, including the friends of forest conservation, and while their application is direct with reference to the entire White Mountain area, they establish a principle which is of far wider application.
>
> The Survey carried forward its investigation in the White Mountains along the lines of trying to show that deforestation and subsequent burning of the vegetal forest mulch results in a more rapid runoff and therefore tends to make unstable the flow of streams. In this it was successful.
>
> The hydrometric showing presented in the preliminary report of results on two small, almost exactly similar, drainage basins on the east branch of the Pemigewasset River of about five square miles each, one largely clothed with virgin timber and the other deforested and burned, is so striking as to render the position of the Survey impregnable.
>
> Careful measurements of precipitation over the areas and of the runoff of the respective streams show that not only was the snow held better in the forested area, but that during a period of 17 days in April, including three extended storms, the runoff of the stream in the deforested area was a comparative flood—practically double that of the stream flowing through the forested area. In Shoal Pond basin (the forested area) the Survey established seven rain gages and 20 snow gages, the engineers visiting these continually during the winter on snow shoes, the snow being from 4 to 7 ft. deep; in the adjoining Burnt Brook basin (the deforested area) it established nine rain gages and 18 snow gages. On both streams hydrometric stations were established and the stream flows determined with a high degree of accuracy. The Survey report shows that the stream discharge from the deforested basin was double that from the forested basin and that the maximum flood flow from the forested basin was only 67% of that from the deforested basin.
>
> The conclusions of Director George Otis Smith, of the Survey, are as follows:
>
> "The comparison between two adjacent basins during critical periods is presented in this preliminary statement as a sufficient showing for the purposes of the National Forest Reservation Commission.
>
> "The results of the Burnt Brook-Shoal Pond Brook studies are held to show that throughout the White Mountains the removal of forest growth must be expected to decrease the natural steadiness of dependent streams during the spring months at least.
>
> "While the intensive hydrometric work was continued to a few headwater tributaries of the Connecticut and Merrimac Rivers, the basins studied were selected as typical for the whole White Mountain area, and the field examinations over this region have shown the tracts now under consideration for purchase to be similar to the basins here reported upon. Therefore, the favorable showing of this report is of general application in the White Mountain area."
>
> Such an actual demonstration and quantitative measure of the performance of different areas, some forested and others deforested, has never been attempted in trying to determine the effect of forest cover on stream flow. Efforts to arrive at definite conclusions have always been attempted on a basis of a study of long-time records of precipitation and stream discharge; but owing to the many qualifying factors, these have simply resulted in divergent opinions and inconclusive controversies. The results of the present actual measurements in these mimic drainage basins, so accurate and refined in method as those approaching laboratory experiments where exact results may be expected, leave no doubt as to the conclusion. Forest cover and the resulting forest mat in the White Mountain granite area does, to a considerable and measurable degree, steady and regulate stream flow, and therefore must be stated as an important factor in maintaining the navigability of streams whose headwaters lie in such areas.

Far be it from us to criticize this exposition of the relation of forests to stream flow. If Congress chooses to split hairs, why should not a government scientific bureau use microscopes on a watershed?

Of course, the "discovery" which the Geological Survey has made is no novelty to engineers who have seen the streams flowing from tracts of varied topography during the spring months in New England. Also, of course, it is stretching probabilities a little—or a good deal—to say that a slight variation in the rate of flood flow on these mountain streams will have any practical effect on the operation of boats in the tidal reaches of the Merrimac and Connecticut, which is practically all the inland navigation that exists on the rivers flowing from these mountains.

But this is only another illustration of the difficulties encountered in stretching the Constitution so that the federal government shall be able to undertake responsibilities for which there is general public demand, but which were never foreseen by the Constitution's framers. An excellent example is the Republican platform plank calling for regulation of the Mississippi River by the federal government.

Why not amend the Constitution so that it would not require straining beyond the limit of elasticity to make it conform to present-day necessities?

*Engineering News, July 27, 1911.

Annual Convention of the National Electric Light Association

The thirty-fifth convention of the National Electric Light Association opened at Seattle on the evening of Monday, June 10, 1912, with a reception and ball at the state Armory. This was also the occasion for the opening of the exhibition of electrical specialties, space for which was reserved at the south end of the Armory building. On the following morning, Tuesday, June 11, 1912, the regular business portion of the convention began, following an address of welcome by Hon. Geo. F. Cotterill, Mayor of Seattle.

An elaborate list of entertainments was prepared by the local committee, beginning with reception and dance and including an automobile tour of Seattle, a boat trip about Puget Sound, trips to the Snoqualmie and White River power developments, teas, musicales and golf contests, besides the inevitable "rejuvenation" of the "Sons of Jove" and a baseball game between the "East-of-the-Rockies" and the "West-of-the-Rockies." The total attendance at this convention was 1473.

General Sessions

The address of the president, J. F. Gilchrist, of Chicago, was a review of the year's activities, with an appeal to the members for coöperation with educational institutions and public-service commissions, and for the study of such troublesome problems as municipal ownership, uniform rates, unimpaired securities, etc.

The report of the Committee on Organization of the Industry, H. H. Scott, of New York, Chairman, showed a total membership of 12,084.

The report of the insurance expert, W. H. Blood, Jr., of Boston, showed greater coöperation between lighting and insurance companies with reduced fire hazards and rates. He noted much work yet undone, however, and commented on the chaotic condition of liability insurance and accident compensation acts.

The report of the Committee on Progress (T. C. Martin, New York City) was in two parts, one relating to general developments and the other to power transmission, read before separate sections. The general part presented statistics on the growth of the electric-supply industry in this and other countries. Progress of the commission-regulation idea in this country was described in some detail and some of the important decisions of the year were summarized. New rate schedules put into effect in Toledo, Cincinnati, New York City and Chicago were reported. A section on municipal ownership discussed the recent revival of agitation for municipal operation of public utilities. General statistics of operation in England were quoted and specific instances of results pointed out in the cases of Milwaukee, Cleveland, Winnipeg, Toronto and Seattle. General advance in station practice such as increase in sizes of turbine units and boilers, use of coal storage, producer gas, oil fuel, advantages in coal testing, improved street illumination, tungsten lamps, etc., were outlined. Another section was devoted to showing the results of supplying electricity for agriculture in Illinois, North Dakota, Missouri, Indiana, Colorado and California. Still other sections discussed electric vehicles, shop power, domestic service, water-works pumping, commercial heating and cooking, etc., as increasing the available load and improving the load factors of central stations. The report closed with a review of the various relations with the public attained by certain companies and beneficial work carried on in improving the relations between employees and companies.

The report on the "Question Box" by E. A. Edkins, of Chicago, showed 3958 questions and 15,189 answers in the 11 years this publication has been maintained. A permanent editorial staff has now been arranged and an attempt will be made to economize space. This report drew much discussion, the comments being largely on the importance and usefulness of the department.

The paper from Paul Lupke, of Trenton, N. J., which has come to be an expected feature of these meetings, bore the title "Expanded Loyalty." The author introduced it as "an attempt to hang a mantle of phrases around the plain, naked truth that 'loyalty is part of that which an employee owes, not simply to his company, but to his industry.'" He also recommended adoption of a code of principles of professional conduct on lines covered by the code of the American Institute of Electrical Engineers.

The second general meeting was opened by E. W. Lloyd, of Chicago, with the report of the Rate Research Committee. This described activities of the year past in studying the systems behind rates throughout the country and endeavors to secure uniform methods of charging, as regards general policy, theory and actual form. The report defined the common rates in use, known as "flat," "demand," "meter," "consumer's output," "two-charge," "three-charge," "straight-line," "block" and "step," according to generally accepted meanings. The committee recommended (1) that its work undertaken of compiling all available electric-rate information be pushed to an early completion and published, (2) that the plan of appointing member companies as assistants to the committee should be continued and a weekly bulletin sent to them, (3) straight-line meter charges for small business, and for large business a charge based on the demand. Elaborate forms for schedules were appended to the report, and the committee recommended that all companies adopt them.

The discussion on rates was drawn out until it had to be sharply interrupted with an invitation to submit written remarks, in order to keep to the schedule. Opinions were markedly at variance. For instance, Arthur Williams, of New York, felt that maximum demand as a basis of charge had been over-emphasized. He would group consumers to get averages and have consumers pay their average proportionate shares of cost. J. W. Lieb, Jr., of New York, stated that geography and politics entered into the problem. He felt that the maximum demand was the logical approach to apportionment of costs but that, after these figures were definitely allocated, then average rates should be made. Samuel Insull, on the other hand, claimed that the cost of investment must enter any logical basis of rate making and this he contended no system of averages would permit. He would absolutely exclude political factors.

C. A. Munroe, of Chicago, presented a paper on the "Desirability of Pumping for Municipally Owned Water-Works as a Central-Station Load." He found that here was a class of business which would yield an off-peak load of 744,000,000 kw.-hr. per year and giving a gross earning of $14,880,000 at 2c. per kw.-hr. He believed that if the business was gone after aggressively, before it became a political issue, it could be secured without difficulty and on a kilowatt-hour rather than a gallon-per-day basis. He believed that with the city pumping plant operated from central-station service in place of the old steam equipment, a source of possible competition from municipal lighting outfits would be eliminated and that the saving in pumping costs would create friends for the central station.

H. E. Grant, of New York City, in the paper "Educating Central-Station Employees," showed the organization of the commercial school of the New York Edison Co., the first of its kind to be inaugurated by an electric operating corporation. The school has an executive staff consisting of the manager, instructor-in-charge, and the secretary. Four courses are given: (1) elements of central-station business-getting; (2) hygiene, health and recreation, and psychology; (3) basic principles of salesmanship; (4) scope, policies and organization of the company. The different courses have been arranged to meet the needs of different classes of employees. The school records show the education and experience of each student prior to his engagement with the company and a record of progress since joining. A certificate is awarded to those who complete a course with credit, and prizes are to be given for excellence in scholarship.

Public Policy

One of the sessions of general character was given over to the Public Policy Committee and was generally spoken of as the "public-policy meeting." The report of the committee comprised 30 pages of main text with 50 of appendices. It reviewed the work of earlier committees and called attention to the serious state of industrial unrest which was found again. Companies were urged to most carefully look after their standing in the community and to exercise every care to eliminate public friction, criticism or sense of injustice. The report emphasized the principle that the public is served best by regulated monopolies in public utilities and also urged continued activity in the education of the public into the fallacies of municipal ownership of public utilities. A considerable part of the report was given to a description of welfare work carried on by some of the larger companies, emphasizing the undesirability of underpaid labor, discontented employees, and investigation of hygiene, industrial safety, etc.

The chairman of the committee, Samuel Insull, of Chicago, in presenting the report, dwelt on the fact that the committee represented one-half of the investment in electric light and power business in the United States, or approximately $1,000,000,000. He spoke in extension of some of the findings of the committee.

Electric Shock

At this meeting also was presented the report of the Commission on Resuscitation from Electric Shock. The report related how the older rules, commonly seen about the country, described only the Silvester movements for artificial respiration and that there are now differences of opinions as to the utility of these, compared with other methods. This commission was organized by representatives of the National Electric Light Association, American Institute of Electrical Engineers and American Medical Association. The commission found itself confronted with three problems: (1) the determination of the best method of artificial respiration that can be instantly applied by laymen, and a clear description of that method; (2) a consideration of special mechanical devices for continuing artificial respiration and the possible invention of a simple and effective arrangement; (3) an investigation of the possibilities of restoring the fibrillating heart to natural pulsation.

The third of these problems was not touched. In the first problem, the commission favored the Shäfer or "prone-pressure" method on account of simplicity and ease of use. This prone method consists in laying the victim on his abdomen and applying pressure rhythmically on the loins and lowest ribs. Extended consideration of the second problem was left for the future. Enough was said, however, to lead one to expect that apparatus might be expected in a short time which would prove an important adjunct to the prone-pressure treatment.

D. B. Rushmore, of Schenectady, then delivered his lecture, illustrated by lantern slides, dealing with the "electrification of the Panama Canal." He briefly sketched the more essential features of the construction of the canal, with lantern slides to give point to each, and briefly voiced his pleasing impressions of the spirit and success of this great enterprise.

The final general session was opened by a paper from Dr. W. R. Whitney, of Schenectady, N. Y., which outlined some of the improved qualities of common metals (as iron and copper) which have been secured in each advance of electrical design, and showed the increasing uses of the rarer metals like tungsten, chromium, boron, titanium, vanadium, silicon, molybdenum, etc.

The report of the Street-Lighting Committee was read by J. W. Lieb, Jr., Chairman. It comprised (1) a history of street-lighting equipment, (2) an outline of the points to be covered in the investigation of street-lighting arrangements, and (3) abstracts of proceedings in several street-lighting controversies. In the discussion the paper was hailed as one of the most practical and useful documents presented.

Business Proceedings

The rest of this last session was filled with business matters. Several constitutional amendments were adopted. One of these enlarged the Class D membership to admit bankers, brokers and all interested firms or individuals, with all privileges "except to vote, to hold office and to attend executive sessions." Another section was changed so that all lighting companies in cities of over 25,000 should pay in $^1/_{100}$ of 1% of gross earnings without reservations. A third amendment permitted subscriptions from Class D member companies in proportion to the business which they carried on with electric companies and in lieu of the $5 now charged per representative or guest registered at conventions. A fourth amendment permitted the collection of dues in installments from Class B and E members (individuals connected with Class A and D member companies). A fifth change provided for repaying to geographical sections of the Association 50% of the various membership dues to cover the necessary expenses of the section. A similar repayment of $2.50 per member was provided for the expenses of special sections.

A. C. Dunham, of Hartford, Conn., was elected an honorary member. The H. L. Doherty medal for best convention paper was awarded to C. N. Duffy, of Milwaukee. Two other future medals, of silver and bronze, were announced by Mr. Doherty—to be known as the Harriet Billings prizes in honor of the aged assistant secretary and treasurer. The usual list of appreciative and congratulatory resolutions was adopted.

The following officers were then elected: President, F. M. Tait, of Dayton, Ohio; Vice-Presidents, J. B. McCall, of Philadelphia, and H. H. Scott, of New York; Treasurer, W. W. Freeman, of Brooklyn, N. Y.; Members of Executive Committee (for three years), J. A. Britton, of San Francisco, C. E. Grosbeck, of San Diego, Calif., and C. A. Stone, of Boston, Mass.

Engineering Sessions

The first business of the technical sessions was the report of the Committee on Meters. This accompanied a handbook for meter inspectors which included all available information published in recent reports of the meter committees and has incorporated in it those parts of the meter codes which have a bearing on the practical operation of a meter department of a company. The report commented on general developments of meter practice and recommended that some effort be made to have supervisory commissions permit the use of the ampere-hour meter under proper restriction for those smaller classes of customers whose load was not large enough to warrant the installation of an expensive meter. It was believed that concessions in the use of a cheap ampere-hour meter as regards accuracy would make available for small customers the advantages which the larger-load customers enjoyed. Considering the small amount of money involved in the bills, the question of accuracy was held to cut little figure compared with the ability to render the service at all without the larger minimum charges brought by large investments, etc. The code of meter practice which is being built up by the Association was continued as a supplement to this committee's report; Section 5 on wiring protective devices, and Section 6 on installation methods were appended.

The discussion was largely a commendation of the committee for its industry and dispatch. A few called attention to the great value of three-reading tests of meters compared with the slight extra time required over two-point. The Canadian delegates recited the burdensome restrictions imposed on them by the Dominion government, it being necessary for them to put up sealed meters and to preserve the seals for five years.

A paper on "Meter Installations" was presented for S. D. Sprong, of Brooklyn, N. Y. He discussed the commercial side of meter installations, showing for instance that out of 35,000 meters he had found 59% to be of 5 amp. capacity and

20% of 10 amp. size. The average cost he gave as $15, for meter, plus $13 for installing—an investment of $28 per customer and an annual charge of $3.40. He held that with improved lamps it might be economy to eliminate the meter for small customers and give them flat rates.

Several, in discussion, reported economy by careful attention to meter tests; others asked for comparison of meter costs on a customers' kilowatt-hour basis.

Grounding House Lines

The Committee on Grounding Secondaries, W. H. Blood, Jr., of Boston, Chairman, presented the annual plea for grounding alternating-current secondary circuits or house lines as a protection against high-potential shocks. It was stated that the several electrical and insurance associations interested had recently agreed on demanding ground connections for such circuits of 150 volts and less and on permitting groundings above that potential. This report was adopted and referred to the executive committee with the recommendation that it receive the final indorsement of the association as a whole.

Lamps

The report of the Lamp Committee included a résumé of previous reports from 1909-1911, inclusive. The report also showed the growth of the incandescent lamp business during the past five years, according to the following table:

Type	1907 Per cent.	1909 Per cent.	1911 Per cent.
Carbon	93.27	68.98	52.90
Gem	5.88	15.07	19.00
Tantalum ...	0.75	2.12	2.74
Tungsten ...	0.10	13.83	25.36
Total	100.00	100.00	100.00

They found every indication pointing to a further decrease in the output of carbon lamps, this being supplanted in standard sizes by the metallized-filament type. They reported that the tungsten filament lamp had been still further improved, particularly in mechanical strength, so that now they satisfy all reasonable requirements and can be used under all commercial conditions irrespective of position and shock. Under the new types of lamps standardized by the manufacturers were noted the 30-watt metallized for up to 130 volts, and the tungsten in regular and round bulbs of 15-, 20- and 25-watt sizes for 100 to 130 volts. The committee urged member companies to follow a broad and liberal policy encouraging the adoption and use of the tungsten lamp. They found that those companies which had first introduced the higher-efficiency type on favorable terms with aggressive campaigns for new business more than overcame any temporary loss which would have been felt in revenue, due to new business, longer hours, use and better satisfaction.

In the discussion, J. W. Howell, of Harrison, N. J., voiced his belief in the eventual supremacy of the tungsten lamp for all sizes of filament types. He believed that all difficulties of cost, ruggedness, etc., would be overcome.

A paper entitled "The Proper Lamp for a Circuit" was presented by R. E. Campbell and M. D. Cooper, of Cleveland. They held up as four "fundamental considerations," (1) intensity of illumination, (2) quality of light, (3) fluctuation of intensity, (4) maximum economy. They called line-voltage regulation the key to satisfactory service and stated that companies would find it economy to hold full voltage at a customer's lamp.

The Committee on Electrical Measurements and Values, A. E. Kennedy, of Cambridge, Mass., Chairman, in its report described the effect of the changes in the standard candlepower and volt (which were made by international agreement in 1909 and 1911, respectively). In the discussion the commercial effects on the industry were noted—chiefly a theoretical reduction in income by an increase in the value of power units.

The second technical session opened with the report of the Committee on Terminology. This comprised a list of definitions. The committee confined itself to terms directly pertaining to central-station business, such as capacity factor, diversity factor, various load factors, loads and demands, flat-, demand-, and two- and three-charge rates, etc. The report met with no disapproval.

F. N. Jewett, of St. Louis, in the paper "New Current-Consuming Devices," described a line of mechanical single-phase converters for storage-battery charging, etc. The discussion was on the further development and application of such devices.

The paper by Taliaferro Milton, of Chicago, entitled "24-hour Service in Small Central Stations," brought together the operating results from several small concerns where they had found that it was desirable to give a 24-hour service on their wires, but running the generating machinery (direct current) for only a single shift of eight hours, the comparatively light load at other times being supplied by a storage battery floating on the line.

This paper brought out a long discussion, many of the speakers feeling that even the small central station ought to use alternating current for the sake of possible development. The author's annual charge of 15% for battery maintenance, interest, insurance and depreciation was questioned.

Overhead Lines

Farley Osgood, of Newark, N. J., made a brief oral report for the Committee on Overhead Construction, describing the progress made in having the 1911 standards accepted by all interested bodies. He expected that general agreement would be secured by the end of 1912. The American Railway Engineering Association desired the following change in Section 18, which was adopted:

Strain insulators shall be used in guys from wooden poles, carrying any power wire of less than 6600 volts, provided the guys are not through grounded to permanently damp earth. Strain insulators shall not be used in guying steel structures nor required on wooden poles carrying wires all of which are 6600 volts or more, provided the guys are through grounded to permanently damp earth.

Controversies were reported in the matter of tie wires and the following interpretation was adopted:

The interpretation of the National Electric Light Association of paragraph 1 of Section 4, of the report of the overhead line construction committee, as presented at the 1911 convention, is that the ordinary tie form of construction is proper for all 2400-volt railroad crossings, providing the construction conforms to the requirements of Section 1 of the report, and applies only to voltages and conditions as covered therein, and where the crossing span does not exceed 125 ft.

Machinery

The first business of the third technical session was the report of the Committee on Prime Movers. This was a formidable document of 65 odd pages, in which a general survey of developments in the power field was noted. Among the notable points, the following may be noted: (1) a recommendation of the practice of periodically testing water-wheel units, tests to be made by the regular operating force with what reasonable assistance was necessary and with the units in operating condition; (2) the need for adaptation of mechanical stokers to the coal used, particularly in the case of the chain-grate stoker where the thin ash on the back was found to admit so much air that the flue gases from the furnace seldom showed more than 8% CO_2; (3) the use of a simple steam-flow meter to check up the performance of a steam turbine from time to time to see that the condition of blades and nozzles was right, a condition which would be revealed by the consumption, but not by the smoothness of operation; (4) oil specifications for engine fuel; (5) results of tests from 38 oil-engine plants and experiences of operators in these plants. The report also summarized the many developments in power apparatus which have already been noted from time to time in the various technical papers. The report contains profuse references to current literature for the benefit of those who wish to make more extended study.

Discussion of this report was free. B. J. Denman, commenting on the large boilers at Detroit, claimed the high efficiency was due to design rather than care in operation and selection of fuel. Others

emphasized the value of steam-flow meters. The amount of steam lost in oil firing came in for much discussion, claims being advanced of only 2 to 2.5% for California oils, but the general expectation being that 5% was a fair allowance.

L. L. Elden presented the report of the Committee on Electrical Apparatus, which was a summary of progress in design of station apparatus and in station arrangement. Attention was first paid to showing various station lay-outs, both exterior and interior, and commendable from artistic, fire-protection and operating standpoints. In discussing generator design the committee called attention to the lack of progress in utilizing the induction type (an induction motor driven above synchronous speed by a prime mover) and briefly reviewed the advantages of using these machines on systems where there was apparatus of sufficiently high power-factor to furnish the leading current necessary for excitation. The report describes some designs of large high-potential transformers which have been built during the year. Switching apparatus and lightning arrestors were similarly presented.

C. W. Stone, of Schenectady, suggested a saving in substation investment by use of synchronous converters with the two 300-volt generators used in series for railway service and singly for lighting. For over 75,000 volts he recommended delta connections to permit installing arcing-ground suppressors. The Merz-Price (British) system of protection for alternating-current networks (switch-opening relays, controlled by opposed current transformers and thrown when unbalance arises as through circuit defects) came in for much comment. Opinions seem to prevail that modifications were feasible for this country.

The Committee of Underground Construction, W. L. Abbott, of Chicago, Chairman, reported results of inquiries sent out to member companies. They found an increasing tendency of municipalities to demand underground distribution even in residential districts. There were no well fixed standards of construction for such work, however. The report included many cost data on manhole construction and experience with 5500- to 25,000-volt impregnated-paper cables. No litigation was pending in electrolysis cases, but the committee recommended that all the utility concerns in each locality take up this problem on a community-interest basis. Preventive methods were described.

In the discussion fiber or wood ducts and ventilated manholes were reported desirable. Safe temperature limits were asked for underground cables and a good underground inclosed fuse for 2300-volt lines.

In the paper "Care and Operation of Transformers," W. M. McConahey, of East Pittsburgh, illustrated the great need of carefully watching the insulation and temperature of modern transformers. He showed the need of testing oil in oil-cooled transformers frequently to detect the presence of moisture and described a filter-press mechanism for cleaning and drying the oil. A considerable portion of the paper was taken up with a description of how to detect the "polarity" of a series of transformer terminals, so that they could be connected in proper sequence.

Three sessions of great engineering interest were those of the "power-transmission section." The principal feature of the first session was the address of the chairman, H. L. Doherty, of New York. He briefly described the history of the section organization and the aim to bring together the civil, mechanical and electrical engineers with the power consumer, operator and financier. He branched out into a description of the value of the 30,000,000 hp. of undeveloped streams to the farmers of arid lands, and the need of cheaper power from lines of extreme voltage. He attacked the present policy of the national government as obstructing progress and declared that forests were not essential in conserving stream flow.

Electricity on the Farm

C. H. Williams presented the paper "Use of Electricity for Irrigation and on the Farm." It virtually was a 60-page treatise on power farming as practiced in Colorado. After stating that there were 300,000,000 acres of land immediately east of the Rocky Mountains between Canada and Mexico where the annual precipitations average less than 20 in., so that agriculture could not be carried on successfully without artificial water supply, he described some of the early Colorado developments and discussed losses in ditches, by evaporation, by underflow, seepage, etc. He then switched to a description of pumping some underground sources by individual plants on each tract irrigated, and discussed the apparatus and power used, and finally led up to the comparison that it was actually costing $5.85 per acre per season for water in Colorado with a gravity-supply system compared with $2.47 where the irrigation was by local pumping. The paper contained a vast amount of information on the agricultural side of the subject—such matters as (1) the water required for crops like potatoes, wheat, alfalfa, etc., (2) stock feeding, (3) available feeds, etc. The author described the efforts of the Northern Colorado Power Co. to secure every farmer's business in its district, and the forms of contract were appended to the paper. The effect on the company's load, the manifold uses for electric power about the farm and the increased prosperity and comfort of the farmer were described. There was much discussion and many questions were asked about the practices of the Northern Colorado Co. in its rural service. J. A. Britton, of San Francisco, also described the experiences of the Pacific Gas and Electric Co., in developing irrigation farming.

At the second "transmission" meeting it was voted to change the section name to "Hydroelectric and Transmission Section."

Water Power and Transmission

J. C. Hoyt, of Washington, D. C., Engineer-in-Charge of Surface-Water Investigations, U. S. Geological Survey, contributed the paper "Work and Publications of the U. S. Government Relating to Hydroelectric Development." In this he reviewed the activity of the different bureaus and departments and the reports that they had published which gave information on the results of hydraulic and allied investigations. He presented this review of work and publications under six heads: (1) Water Supply (Geological Survey; Engineer Corps, U. S. Army; Weather Bureau; Reclamation Service; Special Boards and Commissions); (2) Topography (Geological Survey; Land Office; Engineer Corps, U. S. Army; Forest Service; Coast and Geodetic Survey; Special Boards and Commissions); (3) Geology (Geological Survey); (4) Climate (Weather Bureau); (5) Social and Industrial Conditions (Census Bureau); (6) Experimental Engineering Data (Bureau of Mines; Bureau of Standards). The discussion turned on the benefit of past coöperation with the Geological Survey in the compilation of surface-water figures and the need of continuing and extending this work.

The report of the Power Transmission Committee renewed the attacks on the government policy of "conservation," declaring that the existing restrictions on water-power sites were burdensome and oppressive. The committee described the present water-power bills in the Senate as unsatisfactory and asked for education of public opinion to stimulate better legislation.

Hon. R. A. Ballinger, of Seattle, formerly Secretary of the Interior, made an address on the development of natural resources. He declared that control of the public domain had passed from Congress to the Executive and that the original policy of parceling out land to *bona fide* settlers had been reversed, making the government a landlord. He stated that the total size of power sites in the public domain was less than under private control, so that it was preferable for the national government to yield control to the states, allowing each locality to regulate its own development.

Following this address, remarks in similar strain were made by H. L. Doherty, J. A. Britton, D. B. Rushmore and Arthur Williams.

The second part of the report of the Committee on Progress was then read. It opened with a review of tendencies of legislation on the development of hydro-electric power and contained some mild criticisms of the attitude of federal departments. Considerable attention was paid to the Wisconsin water-power law (passed in 1911 to compel all persons, firms, associations, corporations or municipalities to obtain a state franchise for building or operating a dam across a stream navigable for any purpose whatsoever) recently declared unconstitutional. After briefly reviewing some significant matters like the proposals in Europe to develop coal gas in the coal seams by the combustion of the fuels therein, the exchange of electric energy across international boundaries, the increasing use of steam auxiliary stations with hydro-electric plants, the sale of American aluminum in Canada at prices considerably below those in the United States, etc., the report passed on to a description of a number of new hydro-electric developments about the country interesting for their hydraulic or electrical equipment.

High-tension Lines

A paper "Switchboard Practice for High-tension Transmission" was read by S. Q. Hayes, of Pittsburgh. This was a review of practice and a description of apparatus like panel, pedestal and desk switchboards, oil circuit-breakers, switches, lightning arresters, indoor and outdoor transformer and switching stations. Illustrations were given of apparatus on the Pacific Slope and in Canada.

The final "transmission" meeting opened with the report of the Committee on Receiving Apparatus for Transmission Lines.

This committee was appointed in the belief that where there are miscellaneous customers with fluctuating loads, some do not use controlling and operating apparatus of a design and in a manner so as to get the best results. The report dealt largely with interruptions to service and, of these, that class of disturbances due to voltage fluctuation. The committee recommended that the most important thing in operation was not to cut out the equipment from the line until the disturbance was shown to be more than momentary. They also recommended the use of induction instead of synchronous motors where maximum continuity of service was the first essential. Where synchronous apparatus was desired on account of better power-factor it was recommended that there should be separate excitation of the field by a storage battery or belted exciter. A form for recording disturbances was recommended and it was hoped that the companies would collect the information in this way and allow the committee to use it in the coming year. This form showed the date and time, load before and after, per cent. of load loss, whether the disturbance was on one, two or three phases, its duration in cycles, and the capacity of the power house back of it.

In the discussion following, the aging of insulators had prominent place. J. A. Lighthipe, of Los Angeles, cited experience with a 75,000-volt transmission line on which the insulators, though testing out nicely when new and also at one year's service, are now steadily depreciating. The only explanation suggested, and this only a tentative one, was that the failure might result from microscopic cracks due to too rapid cooling. The committee was continued for another year.

In the paper "Corona in High-Tension Lines," by G. Faccioli, of Lynn, Mass., three questions were considered: (1) Why is corona dangerous; (2) where is corona to be expected; (3) how can it be prevented. It was shown where corona occurred a critical stress had been exceeded, and that this indicated a probable weak point of the system. Another danger caused by such discharges is in the possible decay of insulation and of conductors through the production of local heat and chemical byproducts such as ozone, nitrous oxides and nitric acid. Corona discharges appear naturally where the electric stress exceeds the critical disruptive strength of air, which happens at the surface of conductors whose diameter is too small or at the end of conductors where the high-tension circuit is interrupted. By increasing the diameter of the conductors and using end spheres of large diameter, the electric stress may be reduced below the critical value. Conductors at the same potential placed in close proximity, or crossing each other, exert a mutual influence which decreases corona and this has led to the use of wire net to prevent this discharge at special points where insulation of a certain specific capacity stops and another type of insulation begins. Metal disks are also slipped onto the conductor between the two insulations. The paper concluded with a description of the 140,000-volt system of the Au Sable Electric Co. (described in Engineering News, May 16 and 30, 1912). From preliminary tests which had been made it appears that when full voltage of 140,000 volts is held at the power house and the line is under-loaded, as at present, the voltage at the end of the line in Flint (with three 3000-kw. step-down transformers connected to the circuit) is 165,000 volts. The loss per mile averaged under each condition is from 15 to 20 kw. When the line was first put in operation the losses were greater, but gradually decreased during the first half hour due to particles of mud, dirt, sleet, etc., which may have been on the conductors and which were eliminated after the voltage stress was left on a short time. With 140,000 volts held at the end of the line by lowering the voltage at the power house to 120,000, an average loss of 3 kw. per mile has been obtained. If a uniform voltage of 140,000 is maintained throughout the entire system, the losses are expected to be about 6 kw. per mile. Local corona appears on the conductors at 134,000 volts, and complete corona at 155,000 volts. The operating voltage of 140,000 is, therefore, just below the critical voltage of complete visible corona.

In the discussion following, D. B. Rushmore explained the term "ionization of air" as a condition in which the atoms of the molecules of oxygen were dissociated, leaving a nascent substance of high chemical activity. He suggested that the pitting of waterwheels might be due to ionized or nascent oxygen. Continuing, he stated that the stimulation of plant growth below a network of highly charged wires was probably due to the production of ozone by corona. W. B. Kerr described effects of bombardment of bus-chamber walls by fine sand, due apparently to corona discharge.

Lightning Trouble

The report of the Committee on Protection from Lightning, S. D. Sprong, of Brooklyn, Chairman, showed that the work in this field has advanced to such a stage that the reports of trouble as ordinarily made up by different companies have little present value, owing largely to the lack of proper recording devices. The committee recommended that, before proceeding along lines now more or less familiar, an expert should be employed to visit certain representative systems to analyze their reports, offer suggestions as to the observation and tabulation, etc., and suggested an appropriation of $2500 to be expended by the Committee for the purpose suggested. A second recommendation was made contingent upon the non-acceptance of the preceding one. This asked that the Committee be given authority to bring the matter to the attention of member companies and to seek from them contributions to a special fund for carrying on the work.

D. B. Rushmore spoke of the great amount of work yet to be done in studying lightning protection and suggested that the large transmission companies employ a lightning expert who would work in harmony with this committee. H. B. Gear, of Chicago, endorsed this plan, but claimed that most member companies were concerned with 200-volt distribution systems and transformers. He called attention to a series of elaborate experiments being made at Chicago which should give reliable data for such lines.

The transmission section elected as chairman, W. N. Ryerson, of Duluth; as vice-chairmen, D. B. Rushmore, of Schenectady, and P. M. Lincoln, of Pittsburgh; and as secretary, Farley Osgood, of Newark, N. J.

Annual Convention of the American Railway Master Mechanics' Association

The 45th annual convention of the American Railway Master Mechanics' Association was held at Atlantic City, N. J., June 17 to 19, 1912, following the convention of the Master Car Builders' Association, reported in our issue of last week, and in connection with the same large exhibit of railway machinery and supplies which was noted therein. Whether it was due to the enforced absence of any formal entertaining on the part of the supply men or not, there was quite a falling off in the total registration at the convention from that of last year, though this falling off was principally apparent in the numbers of ladies and of railway supply men present. In fact, there were quite as many members of the railway associations present as last year, and the attendance in the meetings and the interest displayed there were, if anything, greater than ever before.

H. T. Bentley (Chicago & Northwestern Ry.), the president of the Association for the current year, was in Atlantic City, but, on account of a sudden illness, was unable to preside at any of the meetings, and his place was taken by D. F. Crawford (Pennsylvania Lines), the first vice-president. Mr. Bentley's presidential address was read by the secretary.

This address, after taking up in brief fashion a description of the progress in mechanical operation of railways during the past year, recommended definitely three things. First, the coöperation of the Master Mechanics' Association with the minor mechanical associations of men engaged in railway work; two, the desirability of the promulgation and enforcement of laws and rules promoting safety in railway operation, particularly those forbidding trespass on railway property, which causes the majority of deaths and accidents in railway operation, and, three, the desirability of urging upon the federal authorities a reform in the method of enforcing the federal boiler-inspection act so that there may be uniformity of practice among the various inspectors.

In regard to the question of the consolidation of the two associations, which has been discussed in a number of the more recent conventions, but which at present, according to the report of the committee on the subject, seems to be dormant, the president recommended that while amalgamation of the two societies does not now seem to be possible, it might be advisable to consider the holding of the two conventions in one calendar week with two days at either end of five days devoted to the respective associations, and with the middle day devoted to a joint session. This, he thought, might reduce the length of time required now to attend the conventions.

The work of the Association is carried on principally through reports of committees and discussions thereon. Abstracts of the more important committee reports presented at this year's convention are given below.

Committee Reports

Advisory, Technical—This committee, appointed two years ago to act as the intermediary between the Association and all outside activities and to report on all matters of an engineering or mechanical nature, upon which the society should give out some opinion, has found that, owing to the formation of similar committtees in societies of the higher branches of railway operation, and to the fact that the Master Mechanics' Association has not consolidated with the Master Car Builders' Association, it could not perform the work allotted to it. As its own recommendations then, it was discharged from further duty.

Mechanical Stokers—The report of the Committee on Mechanical Stokers indicated a considerable progress in this device during the past year. The report is given in full on another page of this issue. The discussion developed the fact that with few exceptions the mechanical stokers installed on American railways are proving most successful. So far there seems to have been no definite effort to determine their economy and their installation has been aimed at increasing the boiler capacity of large locomomotives and of reducing the very arduous labor of hand firing such locomotives. On some test runs, a certain mechanical stoker has loaded 11,000 lb. of coal per hr. into the fire, whereas it was stated the best human performance was 8400 lb. per hr., and where the average firemen could only throw 3500 lb. per hr. This latter figure was stated by D. F. Crawford (Pennsylvania Lines) to be the figure above which he thought the installation of mechanical stokers should be made. In passenger locomotives smaller than this on suburban lines, the stoker might be used in order to reduce the smoke nuisance.

In the same discussion, W. J. Tollerton (Chicago, Rock Island & Pacific Ry.), stated that oil burning on locomotives is not a matter of much future interest to most railways, on account of the difficulty in getting the oil. He said that oil burning would probably be discarded in the very near future by all except those roads that own their own wells.

Safety Valves—This committee submitted a report which contained a formula for determining the sizes of safety valves for locomotives and specifications as to the number and size to be applied, the metal recommended for their manufacture, the matter of stamping lifts on the valves, location and spacing in the dome, the kind and sizes of thread to be used and instructions as to tests. There was some discussion as to the probable necessity of having three safety valves the first set at boiler pressure, the second 2 lb. in excess and the third 5 lb. in excess, as specified in the report, and also some comment to the effect that it was hardly necessary to make definite specifications as to inspection, inasmuch as the federal boiler-inspection act provided that. However, the report was accepted as read and passed to letter ballot for approval.

Contour of Tires—A standard tire contour, similar to the present M. C. B. standard, was recommended by this committee for steel wheels for engine and truck wheels. This contour has a flange height of 1 in., and is to be used for all except driving wheels. The committee would not recommend any change in the present driving-wheel contour for road locomotives, but recommended that for switching locomotives a flange of 1 in. in height is perfectly safe instead of the maximum 1½-in. flange, now standard for driving wheels. The committee stated that it could not see its way clear to recommend flanges of wheels under locomotives and tenders being allowed to remain in service when worn below ⅞ in.; a point which it was advised by last year's convention to consider. In the discussion there was considerable debate as to the desirability of a high flange on road locomotives and the excessive taper (1 in 20) of the tread, but the recommendations were accepted and passed to letter ballot.

Steel Tires—The Committee on Steel Tires submitted a specification for steel tires. This specification describes the material, different classes of tires, the chemical composition, the finish, the branding, the samples for chemical analysis, the required physical properties, a falling weight test and the methods of inspection. No one of the committee was present and the specifications were read by the secretary and afterward by vote of the convention deferred till next year for action.

Main and Side Rods—The Committee on Main and Side Rods submitted a report which consisted entirely of formulas for the checking and the design of these parts. The action on the report was deferred until next year.

Flange Lubrication—Continuing its report of last year, this committee stated that it is the general opinion of railroads which have applied flange lubricators, that such application has materially reduced the wear of tires and has consequently resulted in great economy. Furthermore, it has been noted that the wear of rails on curves has been reduced where flange lubrication is used. As in the report last year, it was stated that it now seems that the hydrostatic lubricator is the best type now available. In the dis-

cussion some members reported that engines which had run from 25,000 to 30,000 miles without this lubrication before renewing tires would run from 65,000 to 85,000 miles with lubrication. It furthermore was brought out that apparently there is no slipping on grades, inasmuch as the lubrication is applied to the flanges and not to the treads of the tire. The committee's conclusions are as follows: (1) The value of flange lubrication depends upon local conditions; (2) flange lubrication has proved effective as a means of reducing flange wear, particularly on driving wheels; (3) the effect of lubricant applied to driving-wheel flanges decreases rapidly as distance of the wheel from point of application increases; (4) flange lubrication results in considerable saving in rail wear where sharp curves are frequent; (5) the effect of flange lubrication upon train resistance is not sufficient to make it a factor in tonnage rating.

HIGH-POWER HEADLIGHTS—The Committee on Minimum Requirements for Headlights reported that no further experiments have been made during the past year, but recommended to the convention that it pass a resolution to the effect that it was the sense of the convention that high-power headlights should not be ordered by the government on roads having multiple tracks or using block signals. Such a resolution was passed. It was reported by the committee that a number of the Southern states had high-power headlight bills under consideration.

CAST-STEEL LOCOMOTIVE FRAMES—This committee reported that it was unable to complete a satisfactory report on account of the contradictory testimony as to the methods and quality of steel. It asked, therefore, for more time. By motion of William Forsyth (Chicago, Ill.), the committee was asked to confer with the American Society for Testing Materials in regard to drawing up such specifications.

SUPERHEATER LOCOMOTIVES—There was an individual paper and a committee report, each dealing with the subject of superheater locomotives. The paper, by Profs. C. H. Benjamin and Louis E. Endsley (both of Purdue University) and presented on the floor by Prof Endsley, was merely a report of the progress in the superheat investigations being carried on on the locomotive equipped with the Schmidt superheater, at Purdue University. The paper states briefly:

> It will be remembered that the work reported upon for the last three years was a comparison between the efficiency of the locomotive when using first, saturated steam, and then superheated steam, while developing approximately the same amount of power under both conditions. When the maximum power was obtained upon the locomotive, while using saturated steam, it required the burning of from 120 to 130 lb. of coal per sq.ft. of grate area per hour, whereas when superheated steam was used, and when approximately the same power was developed, only from 85 to 90 lb. of coal per sq.ft. of grate area were burned. This difference in the amount of coal burned while operating with saturated and superheated steam, respectively, is due to the fact that about 25% saving was made in the amount of coal burned.
>
> The work this year has consisted in increasing the power by increasing the cutoff by small increments in an endeavor to burn the same amount of coal per square foot of grate area per hour, as was done while using saturated steam. While we have not up to this time increased the cutoff to such an extent as to make this possible, it is apparent that there will be no great difficulty in burning the same amount of coal. When these tests are completed, it can then be determined to what extent the power has been increased and by what amount the efficiency has been affected. It is evident that if this increase in the amount of coal burned can be effected without decreasing the efficiency of the locomotive, the per cent. of gain in power will be even greater than the per cent. of gain in the efficiency of the locomotive when using superheated steam than when using saturated steam.

Speaking further, Prof. Endsley said that since the above was written, the experiments have shown that the increased cutoff has materially decreased the efficiency of the cylinder, and instead of getting, as noted in the low cutoff tests, an increase of cylinder efficiency of 33⅓% for a 25% coal saving, the 70% cutoff tests showed a cylinder efficiency increase of but 16% for the same saving of coal. It is, therefore, planned in future tests to enlarge the cylinders to a size that will give the same cutoff with the superheated steam engine as with the old saturated steam engine. C. D. Young (Pennsylvania Lines) confirmed this experience by some tests by his road. As a result of these tests he concluded that where piston speed is low and cutoff long, there is no economy in superheating.

The second discussion on superheaters was the result of the report of the Committee on Maintenance of Superheater Locomotives. It has been freely admitted heretofore that the superheater locomotive has great possibilities, but there has been considerable doubt as to the wear of the parts under the excessive heat and pressure developed, and this committee was appointed last year to investigate the matter. The conclusions reached after extensive correspondence among the railways are given on p. 1249 of this issue.

The discussion showed that the committee's report was acceptable to most of the users of superheater locomotives, and that it is the general impression that the maintenance of these engines, particularly their lubrication, is now as well understood as on other locomotives. The question of their repairs or the life of the parts is not settled, on account of the short time they have been in use, nor is their theoretical efficiency precisely known, as was indicated in Prof. Endsley's paper.

LOCOMOTIVE BOILERS—The committee on the Design, Construction and Maintenance of Locomotive Boilers presented a most exhaustive report, compiled from the answers of a lengthy list of questions sent out to the various railway companies. The questions took up details of the design and construction of every portion of the boiler and the answers to them, as compiled by the committee, form a valuable exposition of the present stage of the art. They were so complete and extensive, however, that any attempt at an abstract is impossible. Likewise, the discussion of the report, which took up the best part of one day's meeting, was so directed to particular details that no abstract can be given here. The entire paper and discussion, when printed, should be interesting to all boiler builders or railway mechanical men.

OTHER COMMITTEES—The Committees on Revision of Standards, Safety Appliances, Standardization of Tinware and Engine-tender Wheels did not report anything of consequence.

OFFICERS

The following officers were elected for the ensuing year: President, D. F. Crawford (General Superintendent of Motive Power, Pennsylvania Lines); 1st Vice-President, T. Rumney (Assistant to Vice-President, Chicago, Rock Island & Pacific Ry.); 2d Vice-President, D. R. MacBain (Superintendent of Motive Power, Lake Shore & Michigan Southern Ry.); 3d Vice-President, F. F. Gaines (Superintendent of Motive Power, Central of Georgia Ry.). The Secretary is Joseph W. Taylor, 390 Old Colony Building, Chicago, Ill.

The Capacity of a Locomotive Fireman was discussed at the recent convention of the American Railway Master Mechanics' Association, at Atlantic City. This capacity depends so much on the individual characteristics of the man and the peculiarities of the engine, the train and the road that it is difficult to arrive at any average figure, but it was brought out in the discussion that the ordinary fireman working on a six- to eight-hour run generally does not fire more than 3000 lb. of coal per hour and it was also stated that on the passenger engines from 4500 to 5000 lb. of coal per hour might reasonably be expected. An example of exceptionally high endurance and strength was noted by C. D. Young, Engineer of Tests of the Pennsylvania R.R., who stated that last summer in some capacity tests between Ft. Wayne and Valparaiso, Ind., a distance of 105 miles, a specially recommended fireman handled fuel for three hours at speeds greater than 60 miles per hour at an average of 8400 lb. of coal per hour. This work was done with a No. 5 shovel. It was the opinion of Mr. Young that had the man been provided with a larger shovel he could have exceeded the figures given. He also stated that in the locomotive test plant there were men who could fire as high as 9700 lb. of coal per hour.

Present Status of Mechanical Stokers for Locomotives*

Last year your committee expressed the expectation that this year, judging from the progress which was being made in the development of the mechanical stoker, it would be able to report finally on a few stokers which had been developed sufficiently to render practically uninterrupted service. Your committee also pointed out that the principal benefit to be derived from the utilization of a perfected stoker fulfilling the requirements specified was the realization of the maximum boiler capacity of locomotives with the ultimate result of increasing their hauling capacity and reducing their cost of operation per ton mile of service rendered.

The actual service performance of two stokers complying with the specifications laid down in last year's report, as developed by extensive inquiry among railroads who have heeded your committee's request by lending their aid and installing a limited number upon large locomotives, justifies your committee in now reporting that these two stokers have, in a measure, fulfilled its expectations, inasmuch as the indications are that their service has been sufficiently reliable in practical operation on a large number of heavy locomotives. These stokers are the Crawford Underfeed Stoker, which was described in the American Railway Master Mechanics' Association *Proceedings* for 1910, volume XLIII, and the Street Overfeed Stoker described in the American Railway Master Mechanics' Association *Proceedings* for 1910, volume XLIII.†

Both types of stokers in successful service today maintain the same general principles originally employed. The improvements made on them, which resulted in making their operation practicable, are improvements of detail only, such as would result from the knowledge gained of the weakness of individual details brought out by actual service.

The principal benefit to be secured by the application of the mechanical stoker to large locomotives is the realization of the maximum boiler capacity. When three or four years ago the necessity for passenger locomotives and freight locomotives of still greater capacity than those already in service became apparent, they were not generally considered possible without some device to assist in handling the increased quantity of fuel which it was thought these engines would require. The solution of the apparent difficulty, however, was accomplished to a large extent by providing means which reduced the actual fuel requirements of large locomotives. These means are the superheater, the brick arch, improved boiler, better engine proportions, more scientific methods of firing, and better locomotive maintenance. The fact is being more strikingly realized every day that a 5% saving in fuel amply warrants the installation of apparatus and the adoption of means which may result in a 5% increase in the cost of maintaining motive power.

The net effect of these means as far as the stoker is concerned, in spite of the fact that they tend to increase maintenance expenses, has been to defer, to some extent, the absolute necessity of the stoker as a means on present-day engines to get out of them their maximum capacity. It should not be inferred, however, from this statement that the mechanical stoker does not find application to certain engines in operation today, especially of the larger Mallet types which are in continuous service on long mountain grades. On the other hand, too, as the greater sustained tractive efforts of the large engine equipped with superheaters and brick arches is gradually taken advantage of, its fuel consumption per hour will increase, though decreasing on the ton-mile basis, with the eventual result of possibly making necessary to some extent means, in addition to those already provided, to supply fuel to the engine up to its maximum requirements.

When this condition develops, as it is bound to, by traffic increases, careful investigation of tonnage ratings, and the raising to a higher standard the efficiency of operation, the demand for a perfected type of mechanical stoker will become more acute than ever. It is, perhaps, somewhat of a good fortune that the superheater has stepped in and tided over the difficulty that would have resulted while the stoker was in process of development and the demand for large engines becoming more insistent.

A review of the present status of stokers already called to your attention, as well as a brief description of new stokers under process of development will be in order.

CRAWFORD UNDERFEED STOKER*—This stoker, in service on the Pennsylvania R.R. and the Baltimore & Ohio R.R., has been developed into a practical operating machine, and is being applied to all of the large Pacific type class K-2 passenger locomotives and the Consolidation type, class H-8-C, freight locomotives building for the Pennsylvania Lines West of Pittsburgh. On these lines 45 locomotives are now equipped, and 20 locomotives under construction are being equipped. The Lines East have ten locomotives equipped. The Baltimore & Ohio R.R. reports one Crawford stoker in service on a Mallet engine with a grate area of 100 sq.ft., and a tractive power of 105,000 lb., working compound.

The 45 locomotives on the Pennsylvania Lines West, which include some of the earlier designs, have made a total of 7361 trips up to the middle of March, of which 3640 were 100% stoker fired, 2082 between 75 and 100%, and 1639 below 70%. The "per cent. stoker fired" is in reference to the amount of coal put into the firebox by the stoker; as for instance, a 90% stoker-fired trip means that the stoker fired 90% of the coal while 10% was hand fired, the firing by hand being done to fill up spots in the grates which resulted from imperfect distribution of the coal by the stoker. Some capacity tests on the Western Division of the Lines West were run with a dynamometer car on various passenger locomotives, one of which was a Pacific type equipped with a Crawford stoker. The results of these tests have not been completed so as to become available for this report, but the preliminary figures indicated, with respect to the coal consumption, that the stoker made as good a performance as the skilled fireman selected for the hand-fired locomotives.

The Crawford Stoker applied to the Mallet engine of the Baltimore & Ohio R.R. has been in service about a year. Some difficulty was experienced with this stoker due to the fact that some departures in design were made from the stoker as originally developed, consisting principally in the provision of two cylinders to operate the plungers instead of one. This necessarily added certain complications which subsequently gave trouble. After certain changes, the stoker gave a

*Portion of the report of the Committee on Mechanical Stokers to the annual convention of the American Railway Master Mechanics' Association, Atlantic City, N. J., June 17-19, 1912.

†These descriptions are reprinted as footnotes to the respective descriptions.

*CRAWFORD UNDERFEED STOKER—All the mechanism of the stoker, including the conveyor from the tender, is operated by a single steam cylinder. The coal is fed from the tender through an opening in the floor and is then handled by a feeder and breaker sliding backward and forward in the direction of the center line of the tender. This is not a crusher, but has a limited opening, and is provided to prevent large lumps having access to the conveyor beneath.

Inside of the conveyor, and at eleven points, are placed rake fingers operated from a bar above and extending nearly to the bottom of the trough, and having such a movement as to drag over the coal in moving backward and scraping the coal toward the locomotive in its forward movement.

From the conveyor the coal is led to a point directly beneath the deck plate of the locomotive back of the boiler and dropped into a space where it is pushed by plungers under the mud ring and into two troughs longitudinal to the firebox and below the surface of the grates.

In the bottom of the troughs are additional feeders for conveying the coal to the middle or forward portion of the grate. The plunger or feeder first taking the coal feeds it principally to the back end of the grate, and the additional feeders carry it forward.

The arrangement of these feeders is such that their number can be increased so as to get the desired distribution of coal.

The operation of the steam cylinder is controlled by a small valve in the cab, which is operated by the fireman.

As already stated, one steam cylinder performs, through a system of levers and connections, all the operations of breaking and feeding from the tender to the actual forcing of the coal from the troughs in the firebox to the point where the coal burns.

[See also Engineering News, Apr. 13, 1911, p. 450, for a description of the Crawford stoker.—Ed. Eng. News.]

fair distribution of coal. This stoker is still in service, but has not given quite the satisfactory performance so that it could be termed unqualifiedly successful. Inasmuch as this particular stoker is a modification of the Crawford stoker as now perfected for engines of the type to which it has been applied on the Pennsylvania Lines, some difficulty, as experienced with it, might reasonably be expected.

STREET OVERFEED STOKER*—This stoker is now being built in two somewhat different forms, distinguished from one another as the screw conveyor type and the crusher type. The screw conveyor stoker is built to take screened coal from the tank and distribute it evenly over the grates in the firebox without being handled by the fireman. The coal used by this machine must be passed through a screen having 2-in. square mesh before it is placed on the tank. With this type of machine the fireman has no manual labor to perform excepting that of raking the coal on top of the screw conveyor when the supply in the tank is low.

The crusher stoker is designed to take lump, run-of-mine, or slack coal from the tank and distribute it over the grates in the firebox. With this type of machine, all the coal must be scraped or shoveled into the crusher by the fireman. The parts of the stoker on the back boiler head and the distribution systems are the same with both machines. The primary difference between them is in the means provided for conveying the coal from the tender to the distribution system, the screw conveyor type only needing one engine to operate the entire machine, whereas the crusher type needs two; one for the crusher, the other for the conveying mechanism.

It is the opinion of the designer of the Street stoker that the provision of means for preparing coal on the tender for suitable firing is but a temporary expedient to be used with experimental machines, and that for practical operation of a large number of stokers, it would be more feasible to prepare the coal at the chutes suitable for stoker firing before delivery to the tender. Your committee last year recommended that a stoker, in order to be complete, should be able to handle run-of-mine coal. In this respect the Street screw conveyor type of stoker does not meet your committee's recommendations. The indications, however, are, judging from recent developments, that it will be more economical to concentrate the means for properly preparing coal for stoker consumption at the coal chute with the net gain of reducing to a minimum the complication of a machine which, when applied to a locomotive, will of necessity add to the expense of locomotive maintenance and the likelihood of engine failure.

The total number of Street stokers applied and in service today are 30, 13 of which are of the crusher type and 17 of which are of the screw conveyor type. Sixty-nine stokers of the screw conveyor type are under construction for application to 45 Mallet engines ranging in tractive power from 72,800 lb. and 99.5 sq.ft. grate area to 105,000 lb. tractive power and 100 sq.ft. grate area, and 24 Mikado engines of 60,800 lb. tractive power and 66.7 sq.ft. grate area. The 30 stokers in operation are applied to engines ranging in size and type from 45,700 lb. tractive power consolidation freight, 58,000 lb. tractive power mountain passenger, and 60,700 lb. tractive power Mikado freight to 105,000 lb. tractive power Mallet freight and pusher engines. At the last convention of this Association, eight of these stokers were in operation. From the service rendered by them, as well as the results of individual investigations made by various roads, this number has grown to 30, with 69 under construction for entry into service within the next few months.

General inquiry of different roads which have the latest type of Street stoker in service has developed the facts that its service is satisfactory, as indeed is attested to by the extension of its use; that it permits realizing the fullest capacity of the locomotive boiler; that it permits of carrying a thinner fire than ordinarily possible with hand firing; that with considerate attention, it renders practically uninterrupted service; but that it does not necessarily effect economies in fuel consumption. The fact was also developed that the greatest trouble in the operation of this stoker results from the unfamiliarity of engine crews with it at the time of introduction. It takes considerable drilling to get a sufficient number of men on a division trained so that the stoker may be handled successfully in pool service. This difficulty, however, is a minor one, and naturally follows at the outset of the use of a device new in railroad service. As the stoker becomes more generally utilized, this trouble will disappear.

HANNA OVERFEED STOKER—This stoker, as far as developed, was briefly reviewed in the *Proceedings* of the American Railway Master Mechanics' Association for 1911, volume XLIV. It did not fully meet the requirements of your committee.

As a coal-distributing means, the Hanna stoker has successfully demonstrated its possibilities. It has been in continued service on engines of the Consolidation, Pacific and Mallet types, giving a good account of itself, particularly when the engine crews took a personal interest in its operation.

The manufacturers of the Hanna stoker are revising its design and construction so as to increase the scope of their apparatus to comply with the specifications as laid down by your committee.

BARNUM UNDERFEED STOKER — This stoker as developed so far by the Chicago, Burlington & Quincy R.R. employs screw conveyors located in troughs extending longitudinally just below the grates. The screw conveyors decrease in diameter from the rear of the firebox to the front. Above the conveyors in each trough are a series of inclined plates, adjustable for height and inclination. The clearance between the conveyor and the bottom of the trough may also be adjusted to secure the best results. The conveyors are operated by a transverse worm shaft under the cab deck, which is

*STREET OVERFEED STOKER—This stoker is of the scatter type, in which crushed coal is driven into the firebox by steam jets. It consists essentially of three parts, namely, a crusher, an elevator and a distribution system.

The crusher is located on the tender, a small section of the water bottom being cut to accommodate it. It is of the swinging-jaw type, and the opening is on a level with the tank floor so that the coal can be scraped into it without being lifted. The crusher will take "run of mine" coal with lumps up to 8x10 in. and reduce them to a size which will pass through a slot about 1½ in. in width. It is driven by a single-acting steam engine bolted rigidly to the crusher and direct connected thereto.

The coal, after being crushed, slides by gravity through a boiler-iron trough pivoted to the tender, into a hopper located beneath the deck plate of the locomotive secured thereto and forming the lower end of the elevator casing.

The elevator consists of a double endless chain with drop-forged links, and having malleable-iron buckets riveted thereto. This chain travels in a casing made of gas pipe of standard dimensions. The upper end of this casing is secured firmly to the boiler head and the lower end to the deck plate. At the upper right-hand corner the elevator passes over a steel sprocket wheel which forms the drive. This wheel is, through a worm, driven by a small steam engine bolted to the boiler head.

The coal is discharged from the elevator at a point centrally on the boiler head directly above the fire door. It falls through a distributor hopper into three distriutors, one of which is located centrally and each of the other two on the side, and all above the fire door. From these distributors it is, by means of the distribution system, spread over the grates. The distributors are made of cast iron, extending through tubes which are roled and beaded into the back head of the boiler and the firebox sheet. Each distributor is fitted with a steam nozzle, through which a blast of steam is admitted intermittently for driving the coal into the firebox.

A discharge regulator is provided, which, when moved to the right, will give a heavy fire on the right side of the grate, and, when moved to the left, will give a heavy fire on the left side of the grate. The distributor hopper is provided with a deflector, by movement of which the major proportion of the coal can be fed to the center or the slide distributors as desired.

The steam engines runing at a constant speed are both fitted with shaft governors inclosed in a crank case, and the lower end of the connecting rod and valve rod are the only adjustable bearings. The only attention these engines require is the introduction of a small quantity of oil in the crank case every three or four days. The only other parts of the stoker requiring attention are the three bearing on the crusher and two on the elevator, which require oiling once a day.

It is, of course, desirable to do away with the crusher, and have crushed coal delivered to the tender, as this will reduce the number of working parts of the stoker. The crusher is provided with a relief spring which makes a breakage impossible, and the elevator is made sufficiently strong to stop the engine which drives it without breakage.

With crushed coal on the tender a screw conveyor will be used for carrying it to the locomotive. This conveyor will be protected by a wire netting which will make impossible the introduction of anything which cannot be handled by the elevator and the distributors. The screw conveyor will be driven by the elevator engine, which will be the only engine used with this type of stoker.

rotated by two small steam engines secured on the outside of the frames. A coal crusher on the latest type of stoker as applied to five 2-10-2 type engines recently built for the Chicago, Burlington & Quincy R.R. is also provided. This crusher is driven by a small steam engine located on the tender. It delivers coal to a belt conveyor which transfers it to a transverse trough from which it is discharged into the longitudinal feed troughs.

In addition to the five 2-10-2 type engines equipped above, the Barnum stoker has been in service on a switch engine of the Burlington road operating in Chicago, as well as a Prairie type engine operating in freight service. It is reported as giving good results with both low-grade bituminous coal and lignite. It is further reported that the indications at this time for this stoker are that it is a practical machine, assisting in making steam readily and being free from failure and breakdowns.

DICKINSON OVERFEED STOKER — This stoker was tried out on the Erie R.R. It employed the fundamental principle of coal distribution of the Hayden stoker further developed. It was equipped with a coal crusher and means for conveying coal, consisting of a screw conveyor transmitting the crushed coal to a bucket conveyor incased in a housing, which bucket conveyor in turn delivered the coal to the distributing mechanism. The apparatus was so arranged that it did not in any way encumber the fire-door. The entire machine was driven by two small steam engines; one operating the crusher, the other the conveying apparatus.

The conveying mechanism as well as the distributing device of this stoker were successful, but the coal crusher failed, due principally to its inadequacy. The engines together with a few minor details gave considerable trouble, although the complete combination gave a good showing when in proper repair. For it to be maintained in this condition, however, proved very expensive.

From the experience gained from the above stoker, a second one was designed and built, seeking to avoid all the weaknesses of the first while incorporating all its good points. The modified stoker, as finally placed into operation, used only one engine of a special slow-speed design, special form of boot for the elevator carrying all the gearing to avoid encumbering the engine, an improved conveyor, a suitable coal crusher, and better coal distributing means. This stoker was finally placed into operation during the month of February last, applied to a Consolidation freight engine. It soon developed that snow and moisture in the coal presented new difficulties by causing the fine coal to dry and cake in the elevator buckets, gradually filling them up, which so diminished the elevating capacity of the conveying mechanism that it clogged and stopped, finally resulting in a failure by breakage of the elevator chain. This trouble was probably due to wrongly designed buckets, since the bucket elevating system as employed in the Street stoker works without trouble. During the operation of the stoker, steam was satisfactorily maintained and the apparatus worked smoothly. It is now proposed to do away entirely with the bucket elevator scheme and substitute in its stead helical screw conveying means.

HAYDEN STOKER—Nothing further in the line of development with the original type of Hayden stoker has been undertaken.

BREWSTER STOKER—The Brewster Underfeed Stoker was briefly described in *Proceedings* of the American Railway Master Mechanics' Association for 1911, volume XLIV. A stoker of this type was built and applied to a Consolidation engine of the Erie R.R. This stoker, being the first of its kind built and placed in operation, having incorporated in it several novel features, developed some weaknesses, as well as indicated the possibilities of certain of its new features.

STROUSE OVERFEED STOKER—No further attempt, as far as your committee has been able to determine, has been made to perfect this stoker.

HERVEY OVERFEED STOKER—This stoker was placed in operation on a Mikado engine of the Baltimore & Ohio R.R. As far as developed, it is a distributor only, requiring coal to be shoveled into a hopper from which it is fed to a cylindrical hopper situated opposite the furnace-door opening. From this latter hopper, the coal is distributed in the firebox by means of rapidly revolving vanes, fitted on a shaft driven through a chain and sprocket by a small engine. After several months of experimenting with this stoker, it was removed on account of the difficulty experienced with the distribution of the coal in the firebox.

CONCLUSION

Generally speaking, in consideration of the foregoing review of the status of the mechanical stoker, your committee feels justified in concluding that decided progress has been made during the last year in the development of the mechanical stoker. While the perfection of the superheater and the brick arch have assisted in making possible a larger engine, it is considered, judging from these indications, that the advent of the perfected mechanical stoker will make possible a still larger engine.

(Signed) T. RUMNEY, Chairman,
E. D. NELSON,
C. E. GOSSETT,
J. A. CARNEY,
T. O. SECHRIST,
S. K. DICKENSON,
GEO. HODGINS.

The Maintenance of Superheater Locomotives*

The Committee on the Maintenance of Superheater Locomotives was instructed to consider and report on: (*a*) The best metal for cylinder and steam-chest bushings; (*b*) The best metal for valve and piston rings; (*c*) The best means of lubricating superheater locomotives.

In order to obtain as many data as possible upon which to base its report, the committee issued a circular of inquiry to the members. An analysis of the repljes indicates that the results obtained from superheater locomotives have been very satisfactory.

It is interesting to note that five years ago there were less than a dozen superheater locomotives operating in the United States, whereas at the present time there are about 2500 locomotives in the United States and Canada having fire-tube superheaters.

Minor difficulties have been experienced on a number of railroads; but the great advantages to be derived from the use of superheated steam, such as increased economy of coal and water, increased power, due to the absence of cylinder condensation, the permissible reduction of steam pressure combined with the use of larger cylinders—all obtained without material increase in the size or weight of boiler—leads us to believe that the use of superheated steam in locomotives will increase rapidly.

This being so, it is of great importance to determine the metal best suited for use for bushings and packing rings on modern superheater locomotives, because the use of highly superheated steam increases the difficulty of obtaining proper lubrication, and thus the metal is subjected to more severe working conditions than are usually found with saturated steam locomotives.

It is also important that we know the best means of securing proper lubrication because the efficiency of lubrication has a direct bearing on the life of bushings and packing rings.

A metal suitable for use as cylinder and steam-chest bushings of superheater locomotives should be homogeneous, close grained, tough and of good wearing quality, combined with sufficient strength. It should be tough in order to resist wear, but at the same time it must be of such composition that it can be readily machined.

Replies to the circular of inquiry indicate that Hunt-Spiller gun iron has been used on many railroads with excellent results. This is stated to be an air-furnace charcoal iron, and the process of manufacture, combined with proper chemical composition, seems to

*Portion of a report of a committee before the American Railway Master Mechanics' Association, Atlantic City, June 17-19, 1912.

result in a metal which is well adapted for use with highly superheated steam. The analysis of this iron, obtained by your committee, is as follows: Silicon, 1.40%; phosphorus, 0.35; sulphur, 0.07; manganese, 0.49; combined carbon, 0.80; graphite carbon, 2.20.

Replies indicate that this same iron has been used extensively for piston and valve packing rings on superheater locomotives with very satisfactory results and that an iron of this character is the best metal so far produced for piston and valve packing rings of superheater locomotives.

The importance of properly lubricating cylinders and steam chests of superheater locomotives, especially those using a high degree of superheat, can hardly be overestimated, because if proper lubrication is not obtained, many of the advantages derived from the use of superheated steam are offset by continual troubles from excessive cutting of bushings and packing rings, which keep the engine in the engine house when its proper place is on the road.

There seems to be a tendency to use too much oil in superheater locomotives, with the result that there is trouble from the oil carbonizing on the cylinder heads, pistons and steam passages. The deposit of carbon also tends to diminish the life of the metallic piston-rod packing, as it builds up in the stuffing boxes and under the vibrating cups to such an extent that the packing in a short time is forced to carry a part of the weight of the piston rod and piston head.

On certain classes of locomotives, possibly those having pistons exceeding 24-in. diameter, it is considered by some advisable to lubricate the cylinder independent of the steam chest, but in most cases we believe better results will be obtained by eliminating the connection to the cylinders and delivering the oil to the steam passageway.

We do not approve of the arrangement of oil pipes in which the oil is delivered near the end of the steam chest, as in this case it is probable that part of the oil is lost in the exhaust, due to the difference in pressure between the live and exhaust steam.

A number of roads report that when superheater locomotives were received from the builders oil was delivered to both ends of the steam chest and to the center of the top of the cylinder; but this arrangement has since been changed so that the oil is now delivered into the steam passageway above the entrance to the steam chest, and the feed to the cylinder has been discontinued. The allowance of oil has also been reduced and it has been found that the locomotives are much better lubricated than formerly and there is a marked diminution in the quantity of oil adhering to the cylinder heads, piston heads and steam passages.

There can be no doubt of the advisability of using a good grade of mineral oil having a high flash point, for locomotives using highly superheated steam, because the temperature of the superheated steam is sometimes as high as 600° F. A number of the roads state they have used valve oil having a flash point of about 520° and also special superheater oil having a flash point of at least 585°, and in every case better results have been obtained from the oil having the higher flash point.

Tests have shown that a moderately high temperature has very little effect on the lubricating properties of a good grade of valve oil when the oil is protected by steam, but when the engine is drifting there is, in most cases, no steam in the cylinders, and the bushings are apt to become hot.

There does, however, appear to be a difference in the results obtained on superheater and saturated-steam locomotives. When drifting the conditions are the same on both, but on saturated-steam locomotives the oil deposit on the cylinders is fluid and the condition of the oil does not appear to have changed; while on superheater locomotives the deposit is gummy and sticky to the touch. This difference may possibly account to a large degree for the rapid wear of piston rings and bushings occasionally experienced on superheater locomotives.

When an engine is drifting a good deal with a closed throttle, there is a considerable vacuum in the cylinders and steam chests, and cinders may be drawn through the exhaust and dirt through the relief valves.

This dirt may adhere to the gummy oil on the cylinder walls and convert them into a lap which will wear away the packing rings and piston heads very rapidly.

This theory explains the good results obtained on locomotives where the drifting throttle has been carefully used and is supported by analyses of the deposit found on the cylinders, which show the presence of cinders and dirt in considerable quantities.

The remedy is obviously to obtain a quality of oil that does not make a deposit of this nature at the temperature to which it is exposed, and to provide means either by ample vacuum or bypass valves, or by the admission of steam to prevent over-heating when drifting.

Many roads use a tandem type of metallic packing on account of the importance of preventing the blowing out of the lubricating oil, which might result in the cutting of the cylinder bushings.

During the past year or two, several alloys have been tried that have given satisfactory results, and while the preferable mixture will vary with the type of packing employed, this question is not now a serious one.

It is important to use a type of piston-rod packing which will stand up under the high temperature met with in the use of superheated steam, and considerable trouble has been experienced with packing that had proven satisfactory with saturated steam when this point had not been attended to. The melting point of the packing rings should be higher than the melting point of rings usually found on saturated-steam locomotives.

In conclusion, your committee feels that, in order to insure satisfactory results in the operation of superheater locomotives, it is of the utmost importance not only to use the best metals for parts subjected to the action of superheated steam, but it is also important to take all reasonable precautions to obtain proper lubrication.

When superheater locomotives were first placed in operation it was to be expected that certain difficulties would be experienced, but these difficulties have been overcome one by one and we believe that at the present time, with reasonable care in operation and with proper attention on the part of engine-house forces, superheater locomotives will be no more difficult to maintain than saturated-steam locomotives of the same classes.

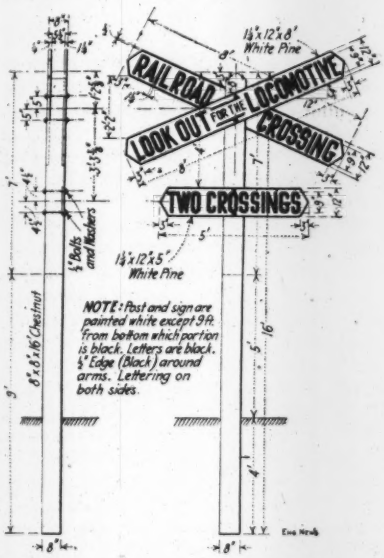
(Signed) R. D. SMITH,
W. H. BRADLEY,
H. H. VAUGHAN,
JOSEPH CHIDLEY,
J. B. KILPATRICK.

Lake Commerce Passing through the American and Canadian canals at Sault Ste. Marie, for the season of 1911, has been reported from the official records at the St. Mary's Falls Canal, Mich. The total freight traffic of 53,477,216 short tons for the season of 1911, when compared with the season of 1910, shows a decrease of 14% and the net registered tonnage of 41,653,488 shows a decrease of 16%. This is the total on both canals.. All of the items in 1911 show a decrease when compared with the season of 1910, except wheat, grain other than wheat, coal and salt. The total number of passengers was 79,951, an increase of 13,018. The passengers through both canals numbered 18,673, showing a loss of 11%. The total lockages numbered 13,292, a loss of 9%. The season of navigation continued for a period of seven months and 25 days, during which the average monthly freight traffic was 6,826,879 short tons and 5,317,467 tons net register.

The traffic through the American canal was 42% of the total freight, 54% of the total net registered tonnage, 51% of the total number of passengers carried. Compared with the season of 1910 there was a decrease of 13% in freight carriage, 16% in tons registered and an increase of 22% of capacity. The American Canal had a season of 237 days. The traffic through the Canadian canal was 58% of the total freight, 46% of the total registered tonnage and 49% of the passengers carried. Compared with the season of 1910 there was a decrease of 15% in freight, 17% in tons registered and an increase of 17% in passengers. The Canadian canal was open for 236 days.

Standard Railway Crossing Signs for New Jersey

To promote public safety by adopting a standard railway crossing sign the Public Utilities Commission of the State of New Jersey recently studied the question of crossing signs and after conferring with a representative of railroads in the state formulated a final design and adopted it. The simplest form was selected as being the most significant, namely, that of two boards crossed at an angle mounted on a post, with proper lettering on both sides. The adopted standard happens to be very close to the standard of the Delaware, Lackawanna & Western R.R. Co. A novel feature is the provision of a separate "Two Crossings" board for cases where a highway


RAIL ROAD
LOOK OUT FOR THE LOCOMOTIVE
CROSSING
TWO CROSSINGS
1¾"x12"x8' White Pine
1¾"x12"x5' White Pine
⅝" Bolts and Washers
8"x8"x16' Chestnut
NOTE: Post and sign are painted white except 9ft. from bottom which portion is black. Letters are black. ½" Edge (Black) around arms. Lettering on both sides.
8"
8"

STANDARD RAILWAY-CROSSING SIGN RECOMMENDED BY PUBLIC UTILITIES COMMISSION OF NEW JERSEY

(For ordinary crossings, the lower board is omitted. When a highway has two railway crossings less than 400 ft. apart, the lower board must be added.)

is crossed by two railroad lines within 400 ft. In this case the sign is as shown in the illustration herewith, while the ordinary crossing sign omits the lower board but otherwise is the same.

There is considerable diversity of railway crossing signs in New Jersey, and this diversity is likely to prove confusing to the traveling public, especially that part which travels in automobiles. If a standard sign appears at all crossings, the traveler will be more certain to take the warning than when signs of various degrees of conspicuousness, various shapes, and different amount and size of lettering, are encountered.

This new standard sign has not been made mandatory upon the railroads, but is *recommended* to them for use when placing new crossing signs or replacing old ones. The number of existing signs (many made of cast iron) is such that it was deemed unfair to the railroads to require them to place new signs of uniform style everywhere.

The description of the sign both for the single and double crossing is given completely by the drawing. It is specified, however, that when the sign cannot be seen at a distance of 150 ft. from the crossing another one shall be erected 150 ft. back.

The question of providing a distant signal in all cases, i.e., setting the sign back from the crossing a distance of several hundred feet, was considered but was rejected. The difficulties of acquiring the necessary rights to place the signs at the edge of the highway in front of private property were considered to be practically insuperable.

The question of illuminating these signs at night has been left for future determination. It is not thought practicable at the present time to require or recommend such illumination generally, although the advantages of having these signs illuminated are recognized.

Comparative Tests of Metropolitan Pavements; New York City*

The President of the Borough of Manhattan, George McAneny, is now asking for bids for various kinds of pavement to be laid on Second Ave. between Houston St. and 23d St. The traffic on this avenue is heavy, as many as 3800 vehicles passing a given point in 10 hours, with a minimum in six separate counts of 2300 in the same time. It is also comparatively uniform for the entire length chosen for the test.

The avenue will be widened between 3d St. and 21st St., increasing the width of roadway from 57 to 60 ft. Both sides of the street-car tracks will be paved with the same kind of material, but the area in and between the tracks will be paved, except from 15th St. to 19th St., with improved granite block, similar to the section from 21st St. to 23d St. The foundation throughout will be 1:3:6 portland-cement concrete, laid on a rolled foundation. The arrangement of the several test sections will be as follows:

(1) From Houston St. to 3d St., asphalt blocks of the usual composition will be laid on a mortar bed.

(2) From 3d to 4th St., Medina sandstone cubes 3½ in. in each dimension, and from 4th to 5th St., Medina sandstone blocks 3½ to 5½ in. wide and 6 to 6½ in. deep will be laid. In both cases the joints will be filled with portland-cement mortar.

(3) From 5th to 7th St., vitrified shale blocks will be used, the blocks and method of laying conforming to the specifications recommended by the Society of Municipal Improvements.

(4) From 7th to 9th St., sheet asphalt, under the Manhattan specification with open binder, will be laid.

(5) From 9th to 11th St., the pavement is to be of asphalt blocks made from imported rock asphalt from one of three European deposits.

(6) From 11th to 13th St., sheet asphalt will again be used, but with a close binder and a surface mixture designed for heavy traffic.

(7) From 13th to 15th St., long-leaf yellow pine will be used. This section will be subdivided into six portions, heavy oil, light oil, or water-gas tar, being injected at the rate of 16 or 20 lb. per cu.ft. in the blocks for respective portions.

(8) Between 15th St. and 17th St., another stretch of asphalt block pavement will be laid; the blocks, however, will be of a slightly different composition from the standard, with a view to making them better able to withstand heavy traffic.

(9) From 17th to 19th St. is another length of wood-block paving, the intersections of 17th St. being of an Australian timber wood known as Tallowood, and the remainder of short leaf pine. The Australian wood is hard and dark, resembling a dark seasoned oak and weighing about 77 lb. per cu.ft. It is untreated, but will be dipped in hot tar before laying and painted with tar after laying. The short-leaf pine will be treated with 16 lb. per cu.ft. of heavy oil, light oil or water-gas tar, making three variations in this section.

(10) From 19th to 21st St., sheet asphalt made from rock asphalt, not necessarily imported, will be used.

(11) Between 21st and 23d Sts., improved granite blocks, 5 in. deep and dressed to give closer joints than heretofore secured, are now being laid with tar and gravel joints.

A traffic census has been taken on a number of days, as already mentioned, and will be repeated at intervals. It is intended to keep accurate data on any repairs made, though all pavements except Medina sandstone and granite, are under a five-year guarantee.

The work will be done under E. V. Frothingham, Commissioner of Public Works; E. P. Goodrich, Consulting Engineer, and H. W. Durham, Chief Engineer of Highways.

*From information furnished by E. P. Goodrich, Consulting Engineer of the Borough of Manhattan, New York City.

A Shay Geared Locomotive of the three-truck type, and with a total weight of 160 tons the largest engine of its type yet built, is under construction by the Lima Locomotive & Machine Co. The engine is to operate on a part of the Kansas City terminal line of the Kansas City Southern Ry., where the maximum grade is 7% and the sharpest curve one of 60°.

The Reconnaissance Survey for the Denver & Rio Grande R. R.: Recollections of an Old-time Engineer

By Augustine W. Wright*

In the spring of 1868 the five parties which had been engaged in the surveys for the Union Pacific R.R. along the 32d and 35th parallels of longitude reached San Diego, Calif., the western terminus of the line. Howard Schuyler and Henry R. Holbrook, two of the party chiefs, were then ordered to return overland with their parties and reconnoiter and resurvey where the outward-bound line had been unsatisfactory.

When they reached Santa Fé, N. M., Charles S. Miller, a member of one of these parties, was ordered to ascend the Rio Grande and report upon the practicability of building a railway by that route. Miller selected Sanford R. Leonard and the writer to accompany him.

We took with us five pack mules, a saddle mule which I rode, and three horses. One of the horses was the property of Gen. W. J. Palmer, then general manager of the company, and was highly valued by him. The other two horses belonged to Col. Wm. H. Greenwood, Chief Engineer of the Eastern Division, and were of tried endurance, for he had at times ridden each of them as much as 90 or 100 miles in 24 hours, the horse carrying grain for his own feed as well as his rider and accouterments.

On May 28, 1868, we started on our long ride. The pack mules were heavily laden with provisions, but we took no tent or other superfluities. The following afternoon we reached the Rio Grande at the Indian town of San Domingo, where we spent the night.

The next day's journey brought us to the mouth of a cañon where the Rio Grande cuts through a high mesa, an extension of the Jemez mountains. A short distance beyond we found our further progress blocked by the perpendicular rock walls of the cañon, and were forced to ascend to the top of the mesa, where we were soon 1000 ft. above the river, which, although it is 250 ft. wide at this point, did not look to be more than 30 ft. This cañon was about 18 miles long, and Miller walked through the part impassable for mules, while Leonard and I went around.

Above its northern end we again descended to the river and proceeded 22 miles to the mouth of another cañon, through which Miller walked to the El Rio Taos. Here we were compelled to ascend the Taos for 30 miles to get across. That night we spent in the town of Taos, where we saw the home of that celebrated scout and Indian fighter, Kit Carson, who had died at Fort Lyon in the fall of the year previous. Descending the river on the north bank, the next day we reached the Rio Grande at a point about 1000 ft. from where we had begun our detour.

Here the cañon walls were about 1000 ft. high and so steep that it was difficult to get our animals down to the water, but we finally succeeded. The water was about a foot below the edge of the bank, and in reaching for it Gen. Palmer's valuable horse lost his balance and fell in. My own mule promptly jumped in and followed the horse to the other bank. The other animals I succeeded in heading off.

The next morning I announced my intention of riding back the 120 miles to get the two animals, but Leonard said he could swim the Taos and save time. That river water, nothing but melted snow from the mountain sides, was as cold as ice, the current was swift and the channel was full of rocks; it did not seem possible for one to live, much less swim in it. But Leonard insisted and we went down to the bank, where he took off his clothes, started, and what is more, succeeded in making the opposite bank, where he climbed out shivering in the cold mountain air, and cutting his feet on the sharp volcanic rocks.

The horse had had quite enough of the cold water and could not be induced to enter it again. I hurried to camp and got some horse-hair lariats. Tying three of these together and fastening a stone to the end we tried our best to throw the line across the stream. We soon found that if the stone were heavy enough to straighten out the lariats, it was too heavy for us to throw across. Meanwhile, for two hours, poor Leonard stood on the opposite bank and shivered.

Finally the stone landed on a rock in the stream, and Leonard went out and got hold of it. He fastened one end around the neck of the horse, and then Miller and I pulled on the other end. Leonard whipped from behind, but our combined efforts could not budge the powerful beast. Then we took a hitch around a small tree while Leonard got a sharp stone and jabbed. The horse pulled back, finally fell and rolled into the river, where the swift current soon swept him to our side. The mule looked after him, hesitated a moment at the cold water, then jumped in. Leonard grabbed her tail; and we were soon ready to resume our journey.

June 6 we reached the lower end of San Luis Park and proceeded to Fort Garland, which is most beautifully situated. From there we continued our journey and on the 15th of the month reached the Saugache settlement, where we rested for the night.

The next morning it was reported that the Mountain Ute Indians were on the warpath and there was plenty of excitement. The Whites abandoned their homes and bringing their more valuable personal property congregated about the settlement store. We remained with them to help in the expected fight; but a friendly chief, Ula, brought his warriors, several hundred strong, and placed them between the warlike Mountain Utes and the Whites. Such an accession of strength awed the Mountain Utes, and the following morning we proceeded on our way in peace.

However, we rode with our rifles across our knees and our revolvers cocked and in our right hands. We passed many of the Mountain Utes, who scowled at us, but did not venture an attack. We proceeded without mishap through the Poncha Pas, to the Little Arkansas River and down it to the Arkansas, reaching the Grand Cañon of the Arkansas on June 20.

Our bread having given out we now started for a white-man's cabin about 40 miles distant. The trail wound over the mountains, down and across the valleys and along the mountain sides. In places it was barely wide enough for our pack animals to walk; and the drop over the side was 800 or 1000 ft.

At one point, when I was in the lead, riding my mule, the pack animals following and Miller and Leonard bringing up the rear, we came upon a place where the trail dropped down a foot perpendicularly, and the ledge of rock on which it ran turned an angle of about 45°.

My mule was afraid to make the jump. Should she fall and go over the edge it would mean a 1000-ft. fall to the bottom. I coaxed and coaxed, but she remained firmly rooted to her tracks. Miller called out to know what was the matter. I explained. We could not turn around. We must go on.

After a half hour spent in coaxing, I decided to dismount. This was no easy matter for the trail was so narrow the mule was already pressing my leg against the rock. I finally got it loose and swung off. Had she moved, or the saddle turned, nothing could have saved me from going over the edge.

I crawled in front of her and took the lines to lead. I rode with a Spanish ring bit, a very severe kind, and there was about 15 in. of chain between the bit and the leather lines. I stepped down to the lower edge, turned to face her, and coaxed her to follow. She looked, sniffed and was afraid to make the step.

After coaxing her for perhaps a half hour longer, I decided to throw her off the trail and try the next mule. All the animals must perish if they would not go ahead. It was impossible to turn around on a 3-ft. trail. So I braced myself, took the reins in both hands, and jerked downward with all my strength.

The chains parted! Backward I went over the edge!!—but, I landed in a ragged scrub cedar projecting out over

*Consulting Engineer, Pomona, Calif.

the abyss. Its roots were among the crevises in the rock. I held on for dear life.

It took me several minutes to recover my nerve.

Would the tree support me? I moved; I tried it; the roots held, and I scrambled up on the trail.

My mule was bleeding profusely, but fortunately I had not broken her jaw. I then tied the chains together with a piece of buckskin, reached out and patted my mule, spoke to her, and she made the jump in safety!

All the other animals followed without accident, and we reached the settlers' cabin that night. They worked all night baking bread for us, and the next morning we were ready for an early start.

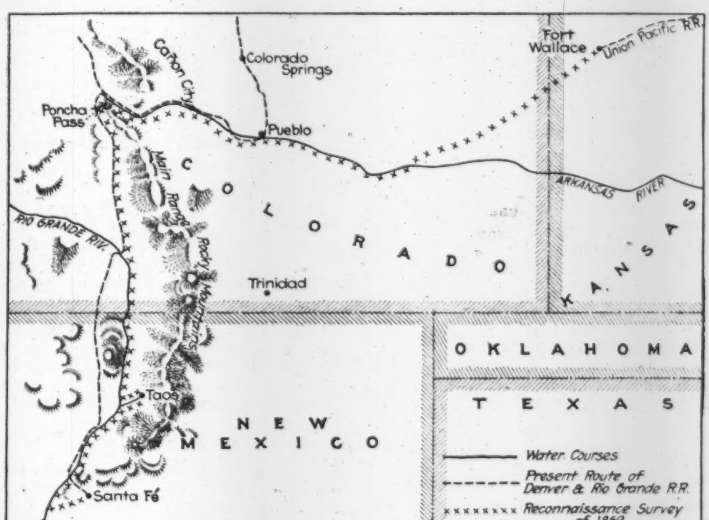
Miller went to the lower end of the Grand Cañon to walk up through it, and we went to meet him when he emerged. Having arrived at the agreed upon place of meeting, about 4 o'clock in the afternoon, we first made a careful examination to ascertain if he had already passed, but finding no trace of him we unsaddled and went into camp.

Dusk falls suddenly in those cañons. We became more and more uneasy as the hours passed and Miller did not put in an appearance. We began to fear he had met with some accident, but it was useless for us to attempt to find him in the night. So I gathered a great pile of brush ready for a fire, had hot coffee ready, and waited.

About 10 o'clock we heard a shot. We answered and set fire to our brush pile. In a few minutes Miller staggered into the firelight, the blood trickling down his face, his clothes torn and ragged. I spent most of the night extracting thorns and cactus from his flesh.

There was a freshet in the river just at that time and the water was unusally high. Within a couple of hours after he entered the Grand Cañon the sharp rocks had cut the soles off his shoes. He had then tied them to his feet with strips of buckskin. His progress had been exhausting in the extreme.

Whenever he met an impassable barrier he had to find some lateral cañon up which he could proceed until he found a place where he could climb to the top. Then he had to descend on the other side, and get back in sight of the point he had departed from. The more inaccessible the place the more important it should be seen and studied. So far as we could learn, no one had ever before passed through the Grand Cañon during a period of high water.



MAP SHOWING RECONNAISSANCE SURVEYS FOR THE DENVER & RIO GRANDE R.R., 1868-69

During the trip he passed several bears, but they did not molest him. Late in the afternoon he met with a large grizzly bear, but, strange to say, it did not offer to attack him, as it ordinarily would have done according to custom. Expecting a hard climb he had not carried his rifle, his only arms being a 40-caliber Colt revolver strapped to his belt and his hunting knife.

About 5 o'clock he reached an impassable point where it was only 50 ft. across, but the rock was bare and sloping toward the river at quite a sharp incline. He was thoroughly exhausted and lay down and looked at that rock. He did not feel equal to a perpendicular climb of over 1000 ft. and thought he could make the other side by running across the sloping ledge.

After a good rest he started, got three-quarters of the way over, when his feet slipped out from under him and he started to slide down the incline. The edge of the bank gave him a 25- or 30-ft. drop into the river. However, he managed to swim upstream far enough to emerge above the point he wanted to get around.

Drenched to the skin, with his ammunition as wet as himself, he struggled on into the increasing darkness, bumping and tumbling into all sorts of thorny trees and bushes, cactus, etc., when suddenly an immense grizzly bear loomed up in front of him!

The grizzly was as large as a horse—the biggest he had ever seen! He took to a nearby tree. In a short time his teeth were chattering with the cold. The bear continued to remain in the immediate neighborhood; he could hear it and at times see its eyes. He tried again and again to shoot, but his wet ammunition would not respond.

Finally he decided to steal by the beast. It was better to be killed by it quickly than to slowly freeze to death. He climbed down and started; and the bear started toward him. No! He did not care to be eaten, so he took to his tree again. This performance took place time and again.

At last he ripped open several cartridges and thus secured enough dry powder to prime his revolver. Taking as good an aim as the darkness permitted he pulled the trigger.

Evidently the ball struck the animal, for, with a great commotion, it fled precipitately through the bushes.

This was the shot we had heard at camp. For hours he had been right near to us.

The next morning when we gathered our stock together to resume our journey, I found Prince, Col. Greenwood's favorite horse, wounded! He was the enormous grizzly bear which had kept Miller up that tree during those hours of suffering! Fortunately Prince's wound was not serious and ultimately he suffered no inconvenience from it.

When any of my readers roll through the Royal Gorge in a palatial train of the Denver & Rio Grande R.R., let them look up at those towering heights and think of what a task Miller achieved.

On June 25, we reached Cañon City and Pueblo on the 28th. Here Leonard received a letter from Col. Greenwood directing him to meet the colonel at Plummer's Mills, near Denver. So he left us, taking one pack mule with him.

Meantime Miller and I proceeded down the river to Bents' Fort, which we reached on July 2, and left on the 4th for Fort Wallace.

The following morning we were out on the open prairie, without shelter of any kind, when we discovered a hundred or more horses approaching at full speed. We lost not a single moment in dismounting, gathering all our stock together and tying them in a circle, head

to head. No Indian showed himself, but that was not unusual.

We got into a depression worn by buffalos in rolling. It was all the protection we could find. Deciding to sell our lives as dearly as possible, we awaited the attack, our rifles in our hands.

Imagine our relief when, upon near approach, we saw that it was a band of wild horses led by a magnificent stallion.

We lost no time in resuming our journey. On the 9th of July we reached Fort Wallace and the next day the end of the track of the Eastern Division of the Union Pacific Ry., thus completing our trip. We took a train for the East.

Miller reported that the line was practicable, and a few years later Gen. Palmer organized the Denver & Rio Grande R.R. Co., and a portion of that railway was built over this identical route.

Charles S. Miller was an engineer of no mean ability. His sweetness of disposition, his droll humor, endeared him to all his associates. When he died a few years ago in Columbus, Ohio, I grieved over the loss of a dear and much valued friend.

Edward Henry Keating*

The death of Edward Henry Keating, on June 17, at his home in Toronto, Ont., has removed one of the most notable engineers of America—a Past-President of the Canadian Society of Civil Engineers, a Member of the Council of the Institution of Civil Engineers of Great Britain, and for 30 years a member of the American Society of Civil Engineers.

Edward Henry Keating was the fourth son of William Henry Keating, a barrister, and for many years Deputy Provincial Secretary of Nova Scotia. He was born in Halifax on Aug. 7, 1844. His early education was received at the Free Church Academy and at Dalhousie College in his native city. He studied engineering under George Whiteman, Provincial Government Engineer, and later under Sir Sanford Fleming, then Chief Engineer of the Intercolonial Ry.

Mr. Keating's first responsible positions were in railway work. He was successively Assistant Engineer of Pictou Extension Ry. in Nova Scotia, Chief Draftsman of the Windsor & Annapolis Ry., Contractor's Engineer in the building of the European & North American Ry. in New Brunswick, and Assistant Engineer on different divisions of the Intercolonial Ry., both in Nova Scotia and New Brunswick. He followed his former chief, Sanford Fleming, to the Canadian Pacific Ry., where he was placed in charge of exploratory surveys as Division Engineer.

From 1872 to 1890, Mr. Keating was City Engineer and Chief Engineer of the water-works of Halifax, N. S. He was also Resident Chief Engineer of the Halifax dry-dock during its construction, which was at that time the largest dry-dock on the American continent. For the greater part of the two years 1891 and 1892, Mr. Keating was City Engineer of Duluth, Minn., where he designed extensive improvements to the water-works system.

While in Duluth he was asked to become City Engineer of Toronto, and in 1892 he returned to Canada to accept that position. For six years, 1892 to 1898, he filled this office and that of Chief Engineer of the water-works. He also had much to do with the improvement of Toronto harbor; the Keating channel, so named in honor of him, will ever serve as a memorial of his labors in this field.

Mr. Keating resigned his office of City Engineer in 1898 to become Chief Engineer and Manager of the Toronto City Ry. Six years later he found a new field of useful activity as Engineer and Manager for the Mackenzie-Mann syndicate in Mexico, where he constructed the street-railway system of the city of Monterey.

Besides the work already mentioned, Mr. Keating during his long and active career designed the water-works of Moncton, N. B., Windsor and Dartmouth, N. S., and large parts of the sewerage systems of Halifax, Truro, Dartmouth and Ottawa. For the past four and a half years he had been associated with Wm. H. Breithaupt in general practice as a consulting engineer.

Mr. Keating was married early in his career to Miss Mary Little Blanchard, of Truro, N. S., who, with two daughters and one son, survives him.

*From data furnished by Wm. H. Breithaupt, M. Inst. C. E., of Keating & Breithaupt, Consulting Engineers, Toronto, Ont.

Notes from Engineering Schools

UNIVERSITY OF ILLINOIS—The Department of Mining Engineering is completing a new mining laboratory, 140x42 ft., divided into two equal sections—one for treatment of ores and the other for coal washing. Coal or ore is crushed, elevated and dumped automatically into any one of a row of steel bins, each holding five tons. Beneath the bins is an automatic traveling scale through which delivery is made to the coal-washing or ore-concentrating appliances. Washed coal is delivered into a 1300-gal. settling tank from which it is elevated to an overhead bin and later carried outside the building, whence it may be carted to the boiler plant. The coal equipment has a handling capacity of five tons per hour.

Ores may be crushed or stamped; the fine screenings are mixed with water and delivered by a sand pump to a three-compartment classifier, thence to a runner, table, bubble, tanks and dryers. Adjoining this section is a completely equipped chemical laboratory and assay room for carrying on such tests as are required in the concentration of ores and coal washing.

The Department is also equipping a new blasting and explosives laboratory, a rock-drilling and coal-cutting laboratory, and is building a new rescue station for giving training with oxygen helmets and other rescue appliances. The offices, drafting rooms, library and recitation rooms of the Mining Department are located in the new engineering building, which will be ready for occupancy Sept. 15. In this building there is also a completely equipped laboratory for the study of mine gases and safety lamps.

The Odessa Accident, on the Chicago, Milwaukee & St. Paul Ry., which caused the deaths of 10 persons on Dec. 18, 1911 (see Eng. News, Dec. 21, 1911, p. 755; May 9, 1912, p. 905), has led to the indictment of the railway company on a charge of negligent use of machinery under its control. The conductor of the wrecked train is indicted on a charge of manslaughter in the second degree and the flagman as an accessory.

A Timber Wharf, at Eagle Rock, an excursion place in the Niagara River, near Buffalo, N. Y., collapsed on June 23, under a load of several hundred people who were waiting to board a steamer for Buffalo. Some 200 persons were thrown into the swift current of the river and between 30 and 40 are reported drowned.

A Steamer was Burned, in the lower Danube River, off the town of Carnadova, in Hungary, on June 20. Twenty-three passengers are reported missing; two of the crew were burned to death, and 57 persons were rescued.

A Head-on Aeroplane Collision, at Douai, France, on June 19, caused the deaths of two army officers, Captain Dubois and Lieutenant Peignan. Both machines were rounding the course at high speed, and the early morning haze prevented the operators from perceiving each other in time to avoid a collision. The wire stays and canvas wings of the two biplanes were interlocked by the force of the impact and both machines crashed to the ground together.

A Cloudburst Followed by a Flood, in the Guanatjuato River, at Guanatjuato, Central Mexico, caused much loss in life and property, on June 16. The city is located in a narrow valley and is the center of a number of American mining industries. After a similar flood in 1905, a drainage tunnel was cut through the mountains to take care of flood waters; but, according to press dispatches, this tunnel proved of too small capacity to prevent damage by the recent flood.

An Earthquake, in Costa Rica, on June 15, is reported to have destroyed the town of Maranjo, and changed the course of a small river at that place. During the succeeding week a number of serious shocks occurred in the vicinity of the Pocas Volcano, which destroyed several small villages.

A Mine Explosion, at the Hastings mine, of the Victor American Fuel Co., near Trinidad, Colo., on June 19, entombed 12 miners, who are believed to be dead. The explosion is reported to

have taken place in a new slope of the mine, about 3000 ft. from the mouth, where development work was in progress. The mine officials are said to assign the cause to a defective blast, which is supposed to have ignited a quantity of gas.

A Cloudburst and Flood caused damage estimated at $300,000 worth of property and the loss of one life, at Buffalo, Wyo., on June 11. A bridge over a small stream dividing the town was washed away.

Another Quebec Landslide occurred on June 2, 1912. The bank of the River Champlain, at St. Luc, Champlain County, Province of Quebec, slid into the river on a length of several hundred feet, completely blocking the stream. The water impounded by the resulting dam did some damage. Fuller details of the occurrence are not at hand. An account of five earlier slides of river banks in Quebec was given in Engineering News of May 27, 1909, p. 576.

The Strawberry Tunnel, of the Strawberry Valley irrigation project, of the United States Reclamation Service, in Utah, was holed through on June 20. This tunnel is 19,200 ft. long and is to carry the water of the Strawberry River, under the Wasatch Mountains. During nearly the whole year of 1911, heavy flows of water were encountered, which considerably delayed the work. The best rubber clothing could not keep the workmen dry and they were constantly leaving. The work of lining the tunnel with concrete has followed closely on the excavation so that the tunnel is now practically completed. It will have a capacity of about 500 cu.ft. per sec. An account of the heavy flow of water encountered in December, 1910, was given in Engineering News of Mar. 30, 1911, by J. L. Lytel, Project Engineer.

The Civilian Appointments in the Engineer Corps of the United States Army are to be made in the ensuing year as a result of examinations to be held Sept. 3-11, 1912. As noted in previous issues of Engineering News, particularly in the issue of April 11, 1912, p. 699, the previous examination for these commissions resulted in the appointment of only one officer out of the four applicants for examination. Full information regarding the examinations may be obtained by writing to the office of the Chief of Engineers, U. S. War Department, Washington, D. C., but it may be noted that aside from age and education requirements, applicants must be eligible for appointment as a Junior Engineer under the Engineer Bureau of the War Department. This eligibility may be secured: (1) By passing a civil service examination; (2) by promotion in the Engineer Bureau of the War Department; (3) by transfer from another branch of the Departmental Service. Inasmuch as most young men who desire to take this examination will be required to pass first an examination for Junior Engineer, it will be necessary for them immediately to take the first steps toward passing the first examination.

7500-kw. Generators for the Keokuk hydro-electric development (See Engineering News, Sept. 28, 1911) are nearing completion at the Schenectady Works of the General Electric Co. On account of the slow speed of the low-head turbines, these generators are of great size for their rated capacity. They are a vertical shaft type, 32 ft. in diameter and 12 ft. high, weighing over 600,000 lb. assembled. The turbines are a single-runner type with a 25-in. shaft revolving at 57.7 r.p.m. In spite of a low rotative speed, the peripheral velocity rises to about 4620 ft. per min., or 52.5 miles per hr. The turbine runners are about 15 ft. 8 in. in diameter and weigh 140,000 lb. The complete runner, including generator rotor, weighs about 550,000 lb.

Low-Water Tests on Locomotive Boilers, to test the comparative safety of boilers equipped with the ordinary radial stay firebox and with the Jacobs-Shupert sectional firebox (described in Engineering News, June 17, 1909), were made on full sized boilers on June 20, 1912, at Coatesville, Penn. Data describing the tests were published in Engineering News, May 30, 1912, p. 1055. A full account of the tests is not yet available, but we have received from the Jacobs-Shupert U. S. Fire Box Co. an account, from which we present the following brief report:

For the purposes of the tests two locomotive boilers designed for high-speed passenger service were mounted in a field 50 ft. apart and were operated from a bomb-proof located 200 ft. from the nearest boiler. Oil was used for the fuel because of the danger to which a fireman shoveling coal would have been exposed. In the process of testing, each boiler was brought to a condition of operation closely approaching maximum power, estimated to be 1400 hp. The supply of feedwater was then cut off, but all other conditions were continued unchanged. The water level gradually fell, under control, in accordance with a prearranged plan, exposing the crown sheet and other portions of the heating surface to the full effect of the fire.

The boiler having the Jacobs-Shupert sectional fire-box was continuously tested under these severe conditions for 55 min. without developing any failure, notwithstanding the fact that the level of the water fell to a point more than 25 in. below the crown sheet. The exact level to which the water fell will be determined later by inspection of the surfaces exposed to the heat, but the water gages only read to — 25 in. The test was then discontinued because the small amount of water remaining did not evaporate sufficiently fast to supply the draft necessary to maintain the fire. At the conclusion of this test, the Jacobs-Shupert firebox was apparently in good condition and ready for further service. The boiler pressure varied between 215 and 225 lb. for 27 min. until the level of the water had reached — 18¼ in. Thereafter the pressure gradually fell, being 50 lb. at the end of 55 min.

The ordinary radial stay boiler was then tested under conditions identical to those above described. After the test of the ordinary boiler had been in progress for 23 min. and the water level had fallen to 14½ in. below the crown sheet, an explosion occurred. The crown sheet and the stays, having become highly heated, pulled away from each other and released the pressure in the boiler. The discharge of steam was through the firebox and the force of the explosion amidst clouds of steam and smoke was sufficient to throw parts of the furnace in all directions for a considerable distance and to lift the entire boiler, weighing 40 tons, several feet above its foundations. The damage to the boiler was such as to make necessary its reconstruction. The pressure varied between 220 and 230 lb., being 228 lb. at time of failure.

Centrifugal Pumps to operate against a head of 1150 ft. are to be installed in the Rand Proprietary Mines, South Africa. A contract for eight such pumps, each with a capacity of 1000 gal. per minute, has been awarded to Escher, Wyss & Co., of Zurich, Switzerland.

A 24,000,000-gal. Mechanical Filtration plant is being built by the water commissioners of Erie, Penn. There will be 12 units of 2,000,000 gal. capacity each, a coagulation basin and a clear-water basin, all of reinforced concrete. The clear-water basins will be beneath the filters. Sulphate of alumina will be used as a coagulant. The purification works are located at the shore pumping station. Chester & Fleming, of Pittsburg, Penn., are engineers for the design and construction of the purification works, and J. C. F. Shafer is engineer to the water commissioners. Henry Shenk, of Pittsburg and Erie, is the general contractor, in conjunction with the Norwood Engineering Co., of Florence, Mass.

The Indictments against four former officials of the Illinois Central R.R., F. B. Harriman, J. M. Taylor, C. L. Ewing and J. E. Buker, for alleged implication in the car repair frauds, by which the railway company was swindled out of $1,500,000, have been dismissed because of the absence of indispensable witnesses, according to a dispatch from Chicago to the New York "Times." Civil proceedings, which had also been instituted, have been settled out of court.

Baltimore's High-pressure Fire Service was given its formal acceptance test, May 20. Eighteen hose streams were put into action at once at the Court House plaza and the water was sent to a height of about 150 ft. No hydrants or water plugs of the usual type are used. Instead there are special connections in manholes at intervals of 170 ft. along the high-pressure pipe line, to which can be attached hydrants of a special form which are carried on the motor hose wagons. The firemen can attach one of these portable hydrants at any one of the manholes. Each hydrant has four hose connections, each with its own pressure regulating valve.

A 100,000-volt Transmission Line Accident on the Central Colorado Power Co.'s line from Boulder to Denver is described in a recent issue of the "Electrical World." One of the No. 0 hemp-center stranded copper wires broke, Apr. 14, at the middle of a 500-ft. span, the broken end falling to the ground in a plowed field. The line was carrying 3700 kw. at the time, but the connection established through the ground continued to carry the load for seven hours, until one end of the wire finally burned back to a point where it hung suspended from the tower insulator. On the ground between the towers of the affected span, the conductor was found lying in sections averaging 6 in. long, with a cone-shaped fulgurite below the end of each in the clay soil, where the earth had been fused to a mass of slag. The explanation was that as each section of conductor burned off, the live end left had established a new point of contact about 6 in. from the end, where it was soon severed again. The largest fulgurites or slag masses measured about 8 in. in diameter at the top and tapered to 2 in. at the lower end 18 in. below. The cause of the original break was traced to an unraveled strand in the ground wire, which had dropped into contact with the line conductor.

An Explosion on the steam yacht "Cristina," belonging to Frederick C. Fletcher, of Boston, Mass., in New London harbor, June 21, caused the death of one of the owner's guests, Mrs. James N. Jarvie, of Montclair, N. J. The explosion occurred about 7 o'clock in the evening, just as the vessel was getting under way. The after deck was blown upward, but no serious damage was done below the water line. The owner is sure that no explosives were on board, and the only explanation of the accident thus far offered is that hydrogen gas liberated from the electric storage batteries, which were in a tight compartment aft, mixed with air and was ignited by a spark. The "Cristina" is a twin-screw steel yacht, built this year by Pusey & Jones, of Wilmington, Del. It is fitted with water-tube boilers and an electric-light plant operated by a steam turbine.

Personals

Mr. H. E. Warner, Division Superintendent of the Detroit, Toledo & Ironton Ry., at Springfield, Ohio, has been made Superintendent of the entire system.

Mr. C. W. Cool, of St. Paul, Minn., has been appointed Assistant Superintendent of the Chicago Great Western Ry., at St. Paul, succeeding Mr. S. R. Bunch, resigned.

Mr. C. D. Campbell has been appointed Town Engineer of Galt, Ont., succeeding Mr. E. O. Fuce, Assoc. M. Can. Soc. C. E., who is to open an office in Calgary, Alta., for private practice.

Mr. A. W. Ainsworth, of Denver, Colo., has been appointed to take charge of the new electrical testing and standardizing laboratory of the University of Colorado, at Boulder, Colo.

Mr. Thomas P. Fowler has resigned as President of the New York, Ontario & Western R.R., according to press reports, and on his return from Europe will become chairman of the board of directors.

Col. George Washington Goethals, M. Am. Soc. C. E., Chief Engineer of the Panama Canal, was given the honorary degree of Doctor of Laws by Yale University, on June 19, and by Harvard University, on June 20.

Mr. James F. Walsh, General Superintendent of Motive Power of the Chesapeake & Ohio Ry., has resigned. Mr. Walsh entered the railway service in 1871 as a machinist apprentice with the Cleveland, Columbus, Cincinnati & Indianapolis Ry., at Cleveland, Ohio. For a number of years he was Mechanical Expert for the Galena Oil Co.

Col. William C. Gorgas, Assistant Surgeon General of the United States Army and Chief Sanitary Officer of the Panama Canal Zone, has been awarded the American Medicine Gold Medal for 1912, which is given annually to the American physician who has performed the most conspicuous and noteworthy service in the domain of medicine in the year past.

Mr. Theodore P. Shonts, of New York City, has resigned as President of the Chicago & Alton R.R., and will be succeeded by Mr. B. A. Worthington, until recently Receiver for the Wheeling & Lake Erie R.R. Mr. Shonts is President of the New York Rys. Co., which operates practically all the subway, surface and elevated railways in the Boroughs of Manhattan and Bronx, New York City.

Mr. O. H. Landreth, M. Am. Soc. C. E., Professor of Civil Engineering at Union College, Schenectady, N. Y., and a consulting engineer of New York City, has been appointed to prepare plans and specifications for systems of water supply and purification, sewerage and sewage disposal, street and pavement construction, etc., for the Kawasaki plant of the Tokio Electric Co., of Tokio, Japan.

Mr. Earl E. Hunner, of the engineering staff of the Oliver Iron Mining Co., at Duluth, Minn., has been appointed Chief Mining Engineer of the Arthur Iron Mining Co., which is to operate the iron-ore properties of the Great Northern Ry. in Minnesota. Mr. Hunner is a graduate in engineering of the University of Wisconsin, class of 1900, and has been with the Oliver Iron Mining Co. since 1903; previous to that time he had been engaged in railway and mining work in the West and with the United States Geological Survey.

Mr. H. K. Eggleston, recently General Road Master of the New York, Westchester & Boston Ry., and formerly Supervisor of Track, Bridges and Buildings of the Central New England R.R., has been appointed Steam Railroad Inspector of the Public Service Commission of the State of New York, Second District, succeeding Mr. W. L. Derr, resigned, as noted in our issue of June 6, 1912. Mr. Eggleston began railway work as a water boy with a fence construction gang on the New York Central & Hudson River R.R.

Mr. Joseph H. McNeil, M. Am. Soc. M. E., has resigned his position as Chief Inspector of Boilers and Chairman of the Board on Boiler Rules of the State of Massachusetts, to accept that of Chief Inspector of the Boston department of the Hartford Steam Boiler Inspection & Insurance Co., of Hartford, Conn. Mr. McNeil has been in the boiler inspection service of Massachusetts since 1898. In the reorganization of the department in 1906, he ranked highest in the civil-service examination and was appointed Chief Inspector.

Mr. C. R. Vanneman, Assoc. M. Am. Soc. C. E., for the past two years Steam Railroad Inspector for the Public Service Commission of the State of New York, Second District, has been promoted to be Chief of the recently created Division of Transportation. This department will have charge of the inspection of the maintenance-of-way and operation of steam railways, the investigation and classification of all accidents, and of such special investigations or inspections as may be assigned to it. It is expected that this division will also have charge of the inspection of interurban electric lines.

Mr. J. P. Stouder, formerly with the engineering department of Delaware & Hudson R.R., has been appointed Steam Railroad Inspector of the Public Service Commission of the State of New York, Second District, succeeding Mr. C. R. Vanneman, promoted, as noted elsewhere in these columns. Mr. Stouder has had 14 years' experience in the maintenance-of-way departments of the New York Central & Hudson River R.R., the Boston & Maine R.R., the Chicago & Northwestern Ry., the Missouri Pacific Ry., and the Delaware & Hudson R.R. The salary of Steam Railroad Inspector is $3000 per annum.

Mr. Kenneth C. Grant, Assoc. M. Am. Soc. C. E., formerly Principal Assistant Engineer of the Pittsburgh Flood Commission, has been selected by the Flood Commission and the City Planning Commission, of Pittsburgh, Penn., to study and report on river improvements, reservoir systems for flood prevention, wharf systems and matters relating to river transportation in Europe. Mr. Grant will sail from New York, on July 2, for Bremen, Germany, and during the summer will visit inland river cities, situated similarly to Pittsburgh, in Germany, France, Austria, Belgium, Holland and England.

Mr. Morley Donaldson, M. Can. Soc. C. E., formerly Superintendent of the Grand Trunk Ry., at Ottawa, Ont., has been promoted to be Vice-President and General Manager of the Grand Trunk Pacific Ry., in charge of the lines west of Fort William, Ont. His headquarters will be at Winnipeg, Man. Mr. Donaldson was born in Scotland in 1851 and entered the railway service in 1881 as Chief Draftsman of the Canada Atlantic Ry. In the service of this railway he was promoted to the positions of Superintendent of Traffic and Superintendent of the Mechanical Department, and he was General Superintendent from 1898 to 1905. Upon the consolidation of the Canada Atlantic Ry. with the Grand Trunk Ry. system, he was made Superintendent of the Ottawa division of the latter railway.

Obituary

William Butler Duncan, for many years previous to 1888, President of the Mobile & Ohio R.R., died at his home in New York City, on June 20, at the age of 82 years.

Henry Clay Brewster, an engineer employed in the construction of the Madeira & Mamore R.R., in northern Brazil, died on June 6, on board the S.S. "Christopher," while en route to Brazil. He was 40 years old.

Newton V. Smyth, who served a number of years as County Surveyor, of Sonoma County, California, and as City Surveyor of Santa Rosa, died at his home in Santa Rosa, on June 13, from pneumonia. He was a member of the engineering party which surveyed the line of the Yosemite Valley R.R.

Engineering Societies

COMING MEETINGS

SOCIETY OF AUTOMOBILE ENGINEERS.
June 27-29. Summer meeting at Detroit, Mich. Secy., C. F. Clarkson, 1451 Broadway, New York.

NATIONAL MUNICIPAL LEAGUE.
July 8-12. Annual meeting at Los Angeles, Calif. Secy., C. R. Woodruff, North American Bldg., Philadelphia, Penn.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
July 11-12. Summer meeting at Detroit, Mich. Secy., W. W. Macon, 29 West 39th St., New York.

OHIO ELECTRIC LIGHT ASSOCIATION.
July 16-19. Annual convention at Cedar Point, Ohio. Secy., D. L. Gaskill, Greenville, Ohio.

International Street Railway and Light Railway Association—The President, Mr. Janssen, has resigned, owing to press of other business, and the Board of Direction has appointed in his place Mr. de Burlet, General Manager of the Belgian National Local Railway Co., of Brussels, Belgium.

Eng. Lib.

Engineering News

Issued Every Thursday. Hill Publishing Company. NEW YORK, JUNE 27, 1912 Price, 15 cents. $5 yearly. To Canada $7. Foreign $8.

Notable Articles in This Issue

Page

Eng. News—June 27—RUSH

*The Canadian Transcontinental Railway 1208

*Kingshighway Viaduct, St. Louis, Mo. 1226

Annual Convention of the National Electric Light Association 1240

Annual Convention of the American Railway Master Mechanics' Association 1245

OTHER ARTICLES

*Unit Wall Concrete Building Construction, Fort Crockett, Texas; R. C. Hardman 1205

A Summary of Eight Years' Work on the Panama Canal 1206

The Improvement of the Neponset River in Massachusetts 1217

*Water Purification at Minneapolis; J. Arthur Jensen 1218

*Closing a Spouting Oil Well 1225

Electric-Furnace Steel for Rails 1233

LETTERS TO THE EDITOR 1235

Safe Dam Construction; John D. Moore — More Primitive Ferryboats; R. C. Hardman—The Defense of Mr. C. G. Elliott; W. C. Hammatt — Anti-Creeping Devices for Railway Track; C. B. Barrie—Can an Impermeable Core Be Used in Mississippi Levees? — J. C. Morris — Notes and Queries.

EDITORIAL 1237

The Largest Engineering Organization in the World—Specifications for Railway Maps—Concerning the Difference in Concrete—Steel Rails Rolled from Electric-Furnace Steel—Proving That Forests Benefit Navigation.

Present Status of Mechanical Stokers for Locomotives 1247

The Maintenance of Superheater Locomotives..... 1250

Engineering News of the Week 1254

Personals 1255

Engineering Societies..... 1256

*Illustrated.

List of Advertisers..... 64

List of Articles Advertised 66

TRIDENT WATER METERS

A RECORD UNAPPROACHED AND UNAPPROACHABLE

INCORPORATED JUNE 1892
TWENTY YEARS OLD

900,000 METERS MADE AND SOLD

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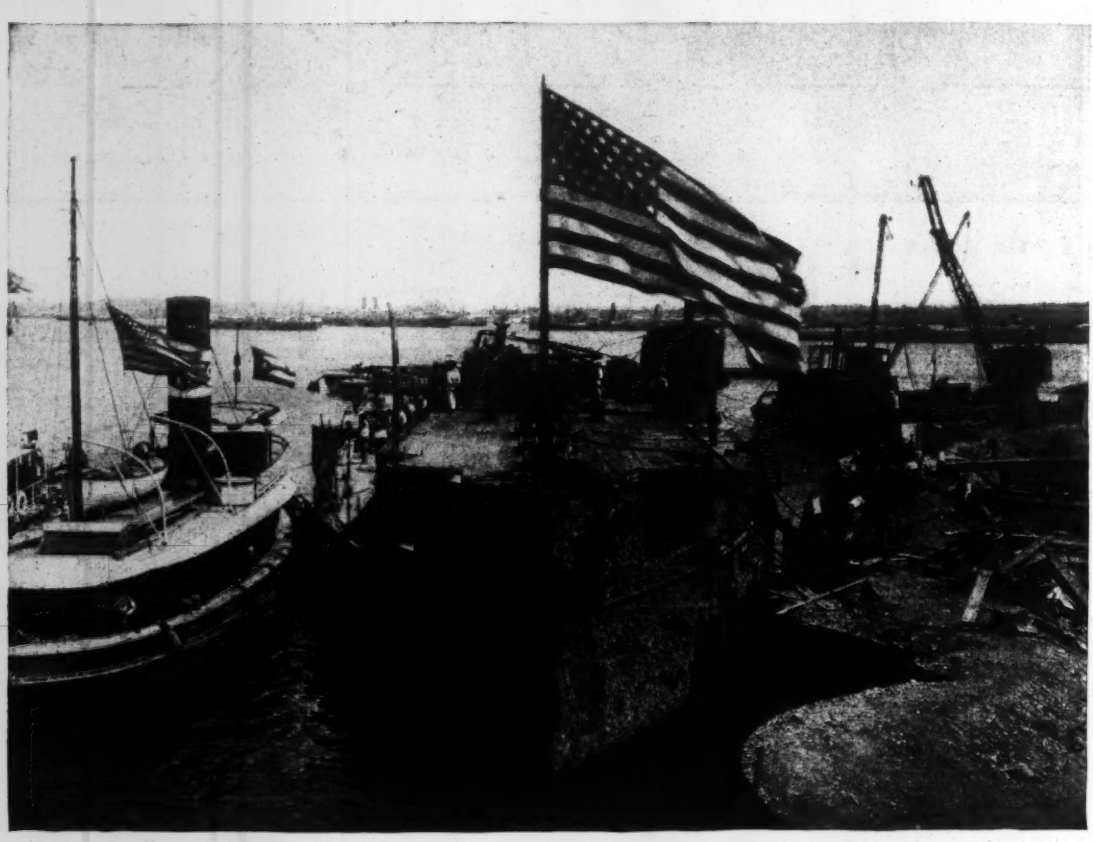
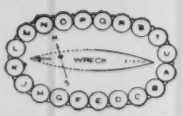


Raising of the Battleship Maine was made possible by Lackawanna Steel Sheet Piling



Even those who formerly had the gravest doubts now know that this noteworthy engineering work was an entire success, and that the successful outcome was largely due to the perfect performance of the Lackawanna Steel Sheet Piling used in the cofferdam, the edge of which is shown at the right in the above picture.

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Lackawanna Steel Sheet Piling has been specified by the U. S. Government, has been used on the two largest piling orders on record and is made in types, sizes and lengths suitable for cofferdams, dams, curtain walls, lining for shafts, breakwaters, docks, piers, irrigation work, foundation for buildings, bridges, etc.

Our engineers are always ready to advise on special requirements, and our stock and large mill capacity permit us to handle any order promptly. Tell us where you need piling and we will quote prices.

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General Sales Office: Buffalo, N. Y.

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18

Factory of Losier Motor Co., Detroit, Mich.
43000 square feet of Fenestra Window Sash was used.

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The galloping pace of these times demands that *one* man do the work of *two*. The business slogan is: "More work in less time."

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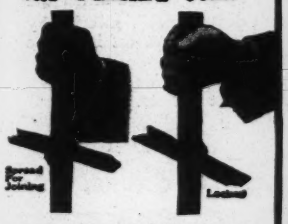
The "Fenestra" Joint



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are a ventilating system that acts as a great bellows for the lungs of your workers—keeping them filled with the air that means health, and scattering the germs of discontent and unrest.

Fireproof, permanent, designed to withstand maximum wind pressure, and to do away with cost of upkeep.

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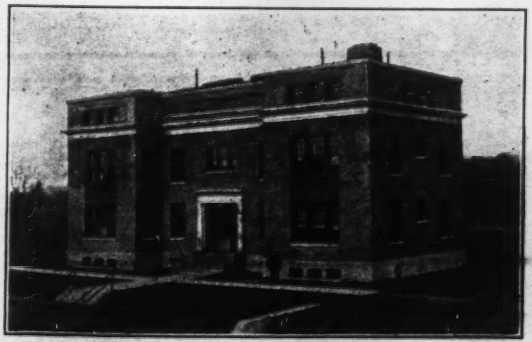

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121. 2

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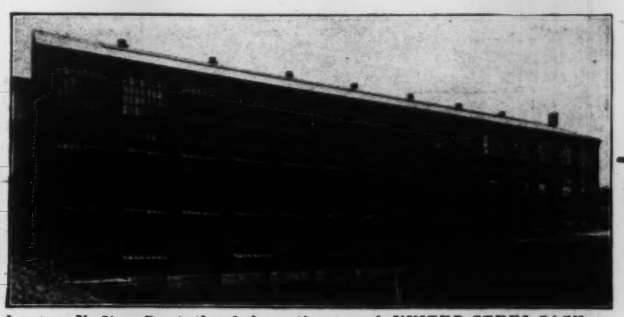

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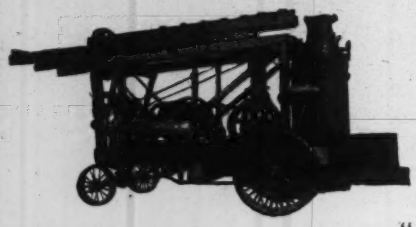

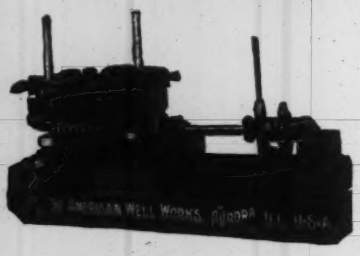

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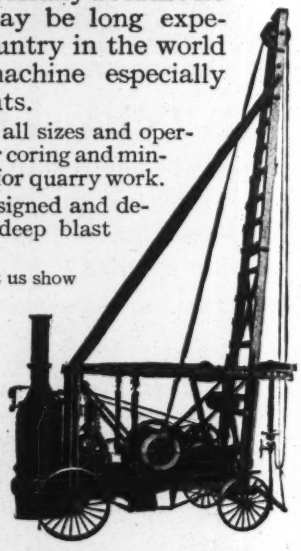

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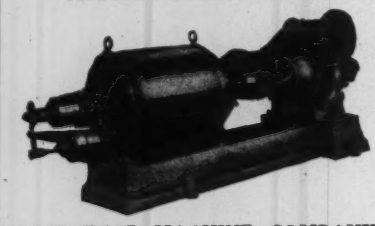

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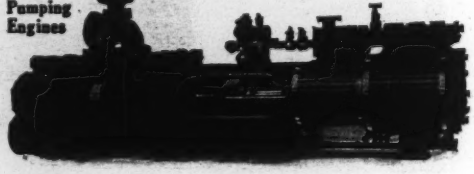
There is not available a better designed nor a better built line of Trade Pumps than offered by us in either the Piston or Plunger types, for light moderate or heavy duty.



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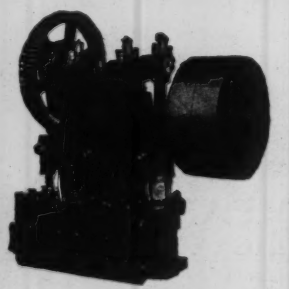

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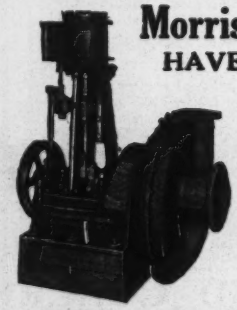

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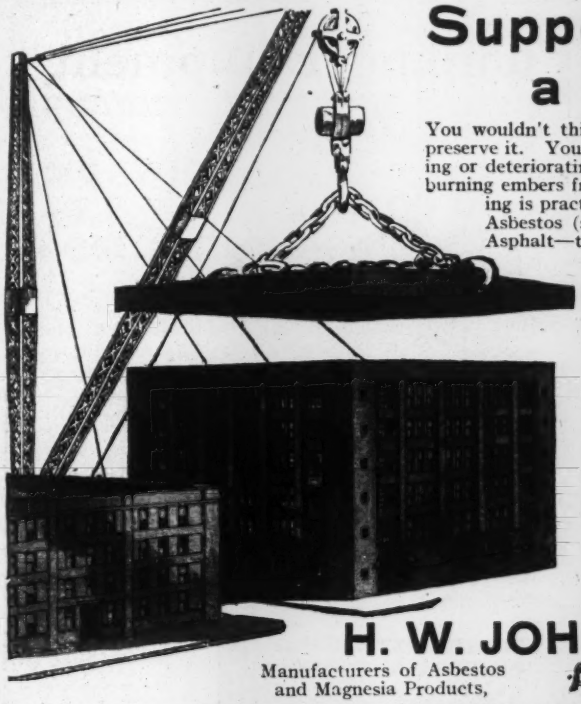

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You wouldn't think of putting coating or gravel on it to water-proof and preserve it. You wouldn't worry about its rotting, rusting, drying out, melting or deteriorating in any way. And you wouldn't be alarmed if sparks or burning embers from a fire next door fell on that roof. J-M Asbestos Roofing is practically such a *stone* roofing. It consists of layer on layer of Asbestos (stone) Felt securely cemented together with Trinidad Lake Asphalt—two *indestructible* minerals.

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is practically indestructible. This is proven by the fact that it is still in good condition on many buildings where it has been in service for more than a quarter century without coating, gravel or repairs. It has withstood the fierce flames of a plumber's blow-torch for nearly an hour without injury or without the boards to which it was nailed being even scorched. Half a century of roofing experience and our positive guarantee of satisfaction are behind J-M Asbestos Roofing. This roofing is suitable for all kinds of buildings in any climate.

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Catalog No. 8.

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Waterproofs and stops leaks in concrete.

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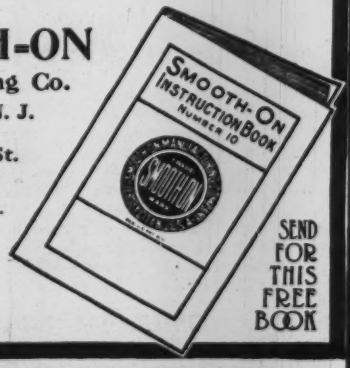

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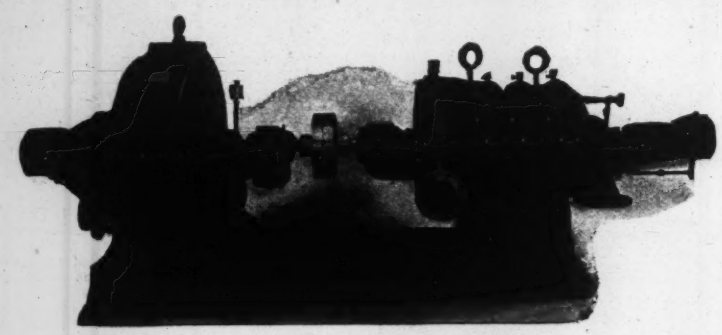

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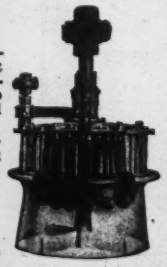

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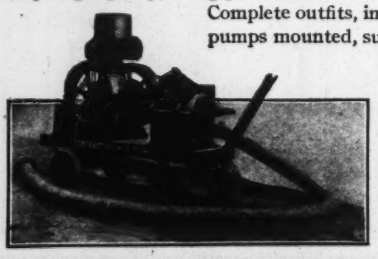

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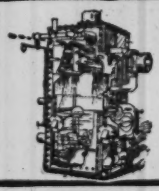

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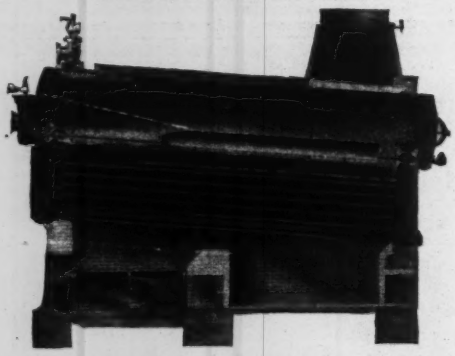

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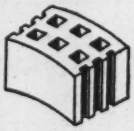

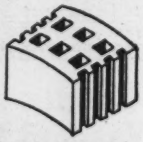

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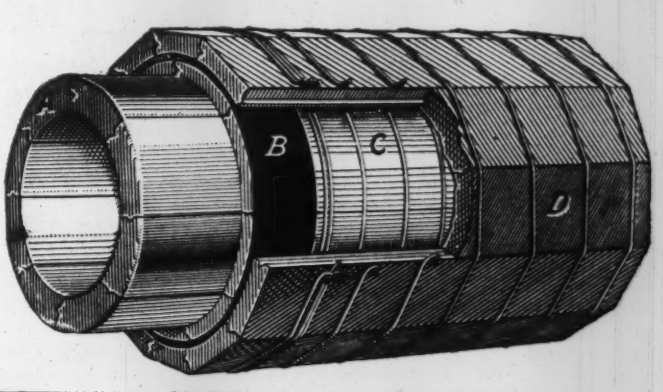

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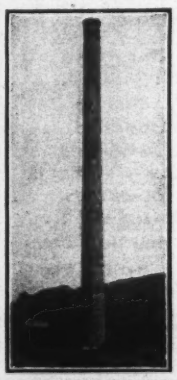

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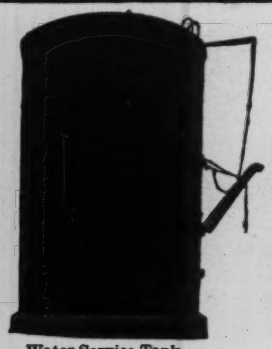

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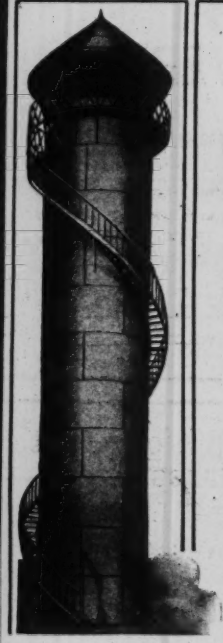

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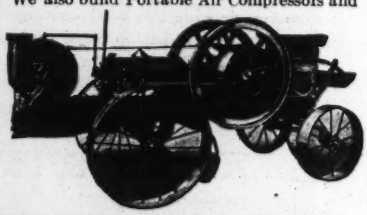

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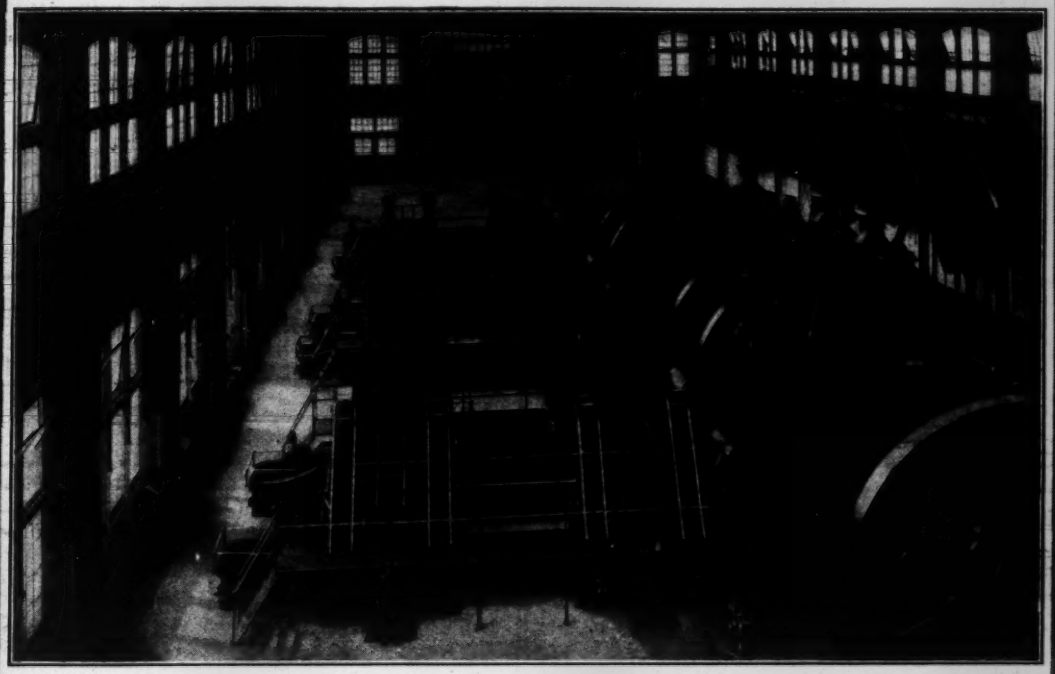

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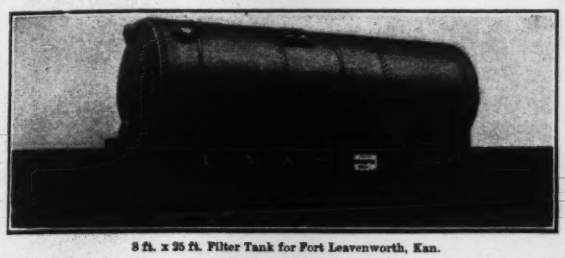

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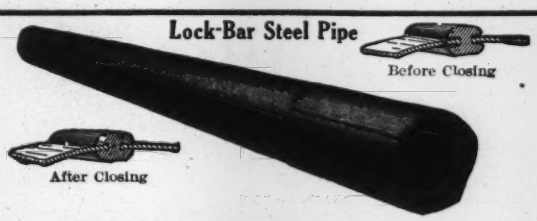
Lock-Bar Steel Pipe



Before Closing

After Closing

100% EFFICIENCY at Lock-Bar Joint. 15% greater carrrying capacity than Riveted Pipe.
LONG LENGTHS means FEW JOINTS

Lock Bar Pipe Has Never Failed in Service

EAST JERSEY PIPE CO.
RIVETED PIPE, TANKS, STAND PIPES, STEEL LININGS
50 Church St., New York City Send for Catalog. Works: Paterson, N. J.

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For Any Service

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Of graphite of all kinds, paints, graphite lubricants, crucibles, lead pencils, etc. *Illustrated Booklets on request.*

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Route of the "Pennsylvania Special," "The Pennsylvania Limited," "The 24-Hour St. Louis," "Chicago Limited," and "Congressional Limited"

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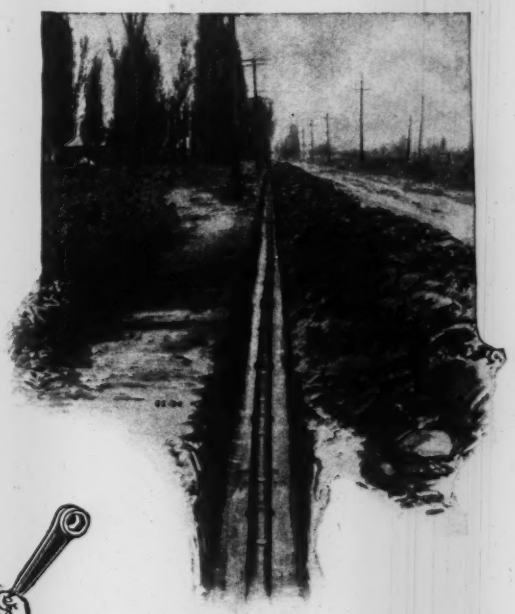
UNIVERSAL PIPE Destined to universal use



ANY man can lay Universal Pipe. He need not have had previous training. He can do it alone if there is no one to help him. The only tool he needs is a ratchet wrench.

Two men and two wrenches make a full, well equipped gang for laying the smaller sizes of Universal Pipe.

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THE CENTRAL FOUNDRY COMPANY
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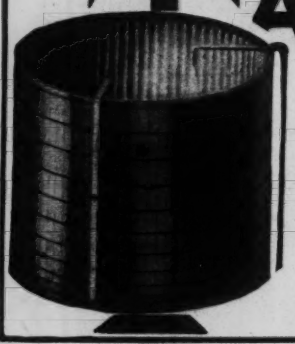

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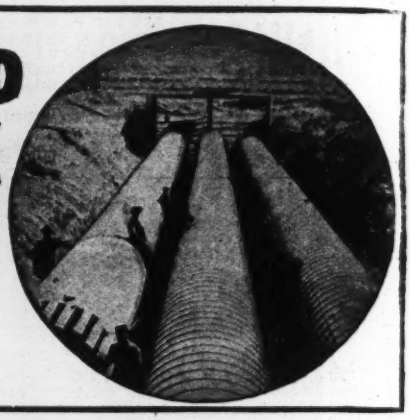

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Wood Stave Pipe

Made of Oregon or Douglas Fir

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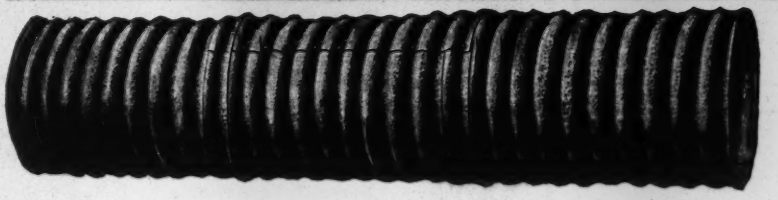

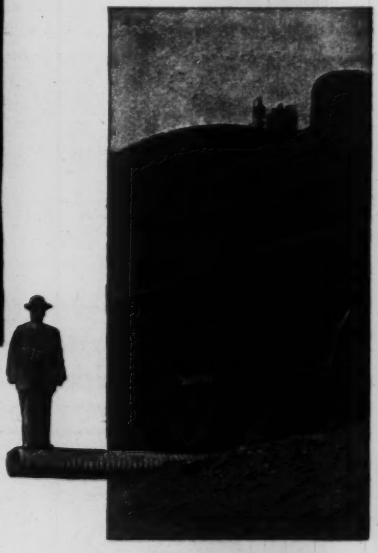

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It cannot leak or stick and requires no repairs or adjustments.
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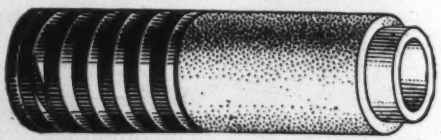

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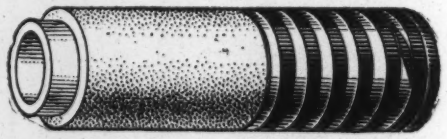

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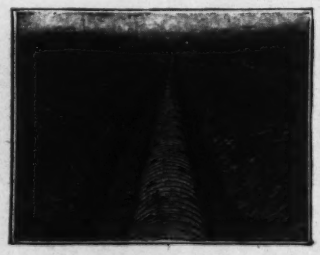

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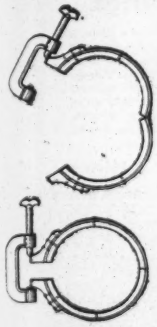

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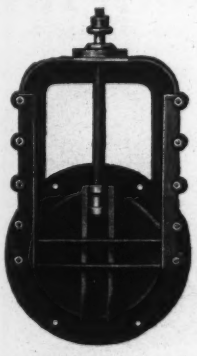

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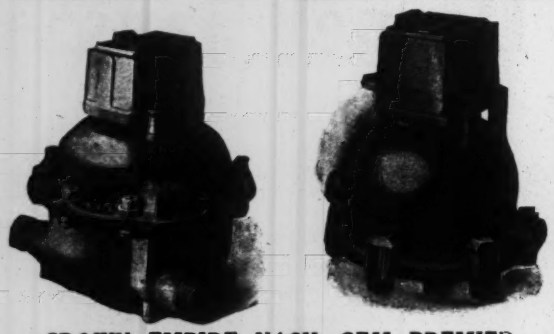

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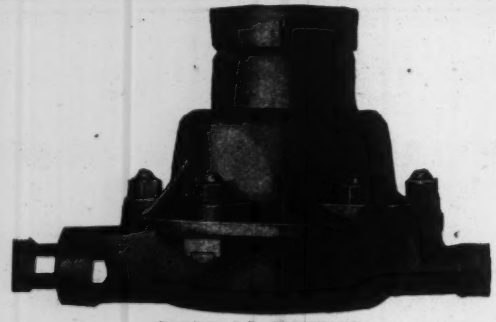

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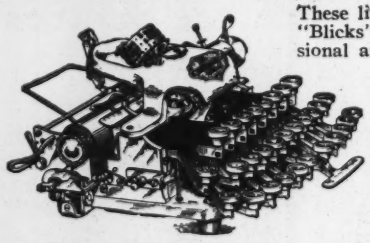

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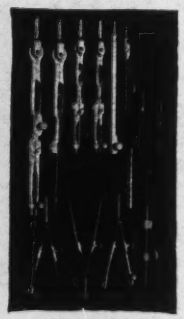

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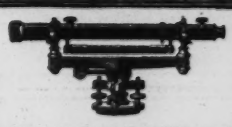

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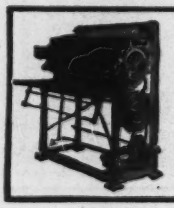
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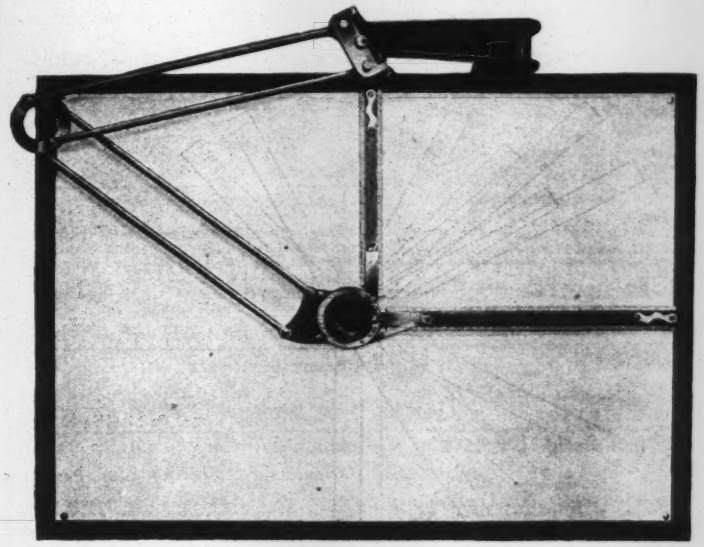

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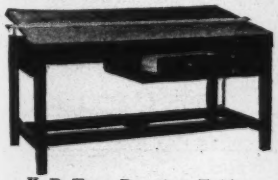

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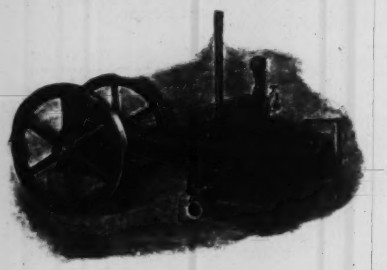

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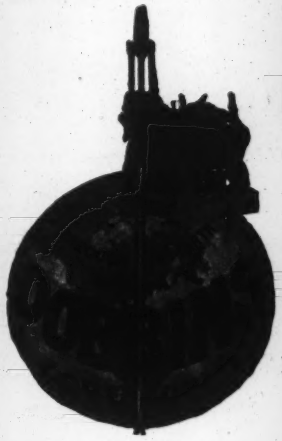

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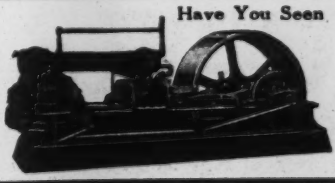

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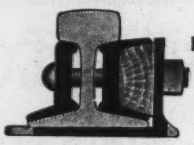

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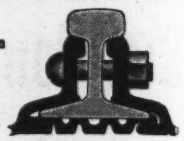

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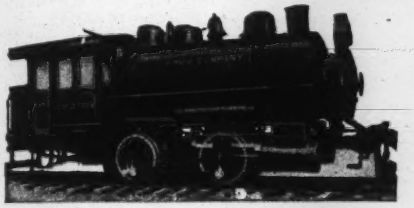

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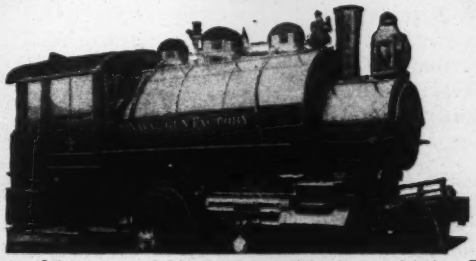

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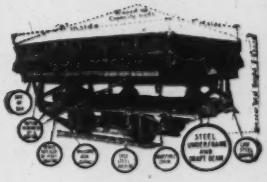

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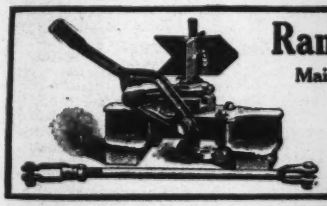

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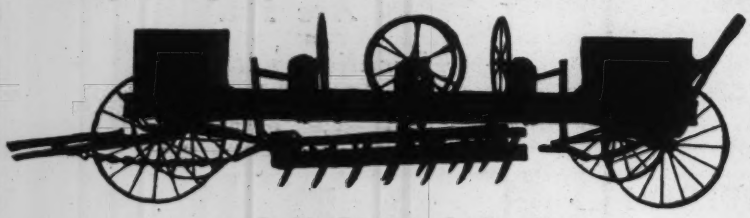

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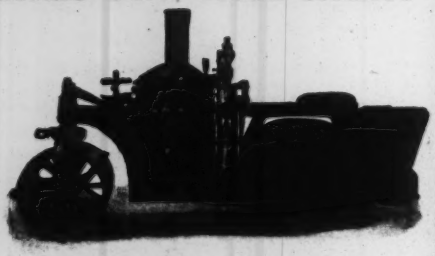

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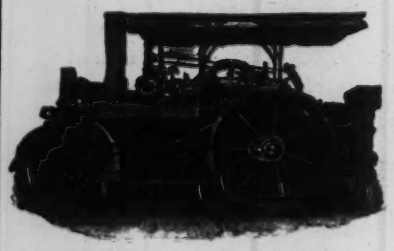

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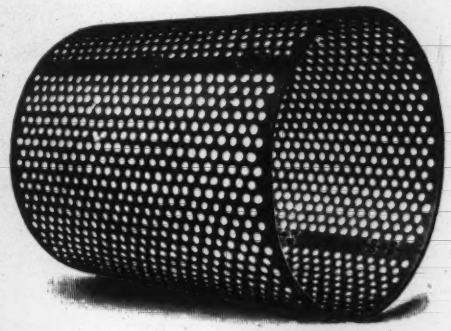

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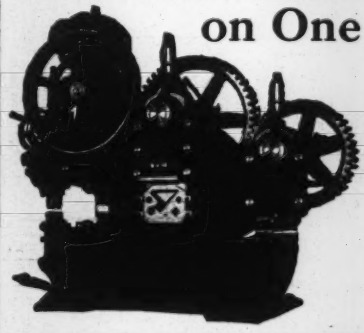

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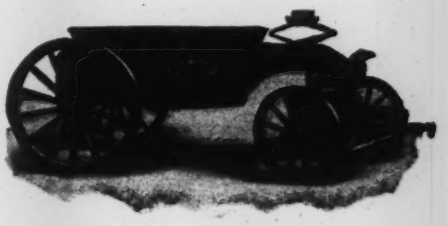

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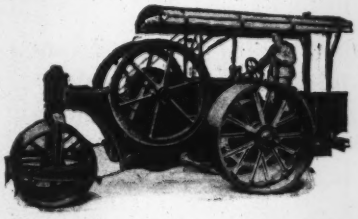

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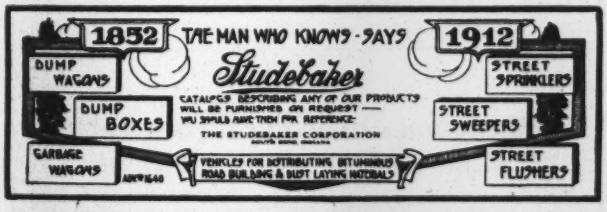
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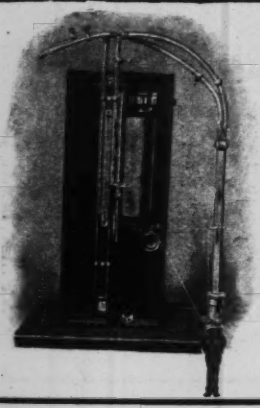

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Bulletin No. 68 describes Venturi Hot Water Meters.

Bulletin No. 75 (just issued) describes Venturi Cold Water Meters.

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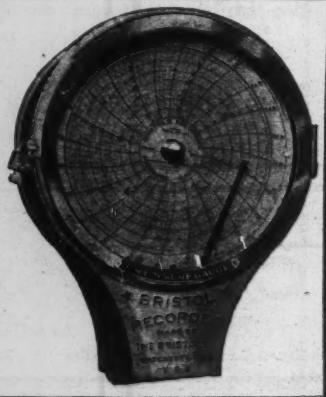

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Designed for the Use of the Locating Engineer.

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The Burt Unit Oil Filter

The 20th Century Way To Economical Lubricating

It isn't what we say about our filters—it's what the users say that counts. This letter gives you one user's opinion.

Carnegie Natural Gas Company

General Office: Carnegie Bldg.
Pittsburg, Pa.

Pittsburg, Pa., Oct. 24, 1905.

The Burt Mfg. Co., Akron, O.

Gentlemen—Replying to your inquiry of the 4th inst. beg to advise that the "Unit" oil filter purchased from you and installed at our Waynesburg Gas Compressing Station some time since is reported by our Chief Engineer as doing excellent work.

Yours truly,
N. Johnston, Superintendent.

Burt Unit Oil Filters clean, purify and filter thin or heavy oil and return it in perfect condition.

Manufactured in all sizes from 3 gallons up to the very largest capacity.

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We also manufacture a complete line of Exhaust Heads and Ventilators.
Geo. W. Reed & Co., Montreal, Sole Manufacturers of "Burt" Ventilators for Canada.

CONTRACTS TO BE LET

Proposals for Government, Municipal and Other Work

Street Paving

Steelton, Pa.

Sealed proposals will be received by the Town Council of the Borough of Steelton, Pa., at the Council Chamber until 7:30 P.M. Monday, July 8th, 1912. To be opened at a regular meeting of the Town Council to be held at the said time and place for the sub-grading, paving and curbing of Pine Street from Front Street to Reading Street.

Plans, specifications, form of proposal and form of contract can be had from the Borough Secretary upon the payment of ten dollars, which will be refunded upon the return of the plans and specifications in good condition.

No proposal will be considered unless accompanied by certified check made payable to Leroy H. Sutton, Borough Treasurer, in the sum of $500.00 conditioned on the entering into by the successful bidder of a contract in accordance with the specification and form provided, and furnishing a bond with at least two sureties, or some surety company acceptable to the Town Council in the sum of $2500.00 for the faithful performance of all the terms and conditions of the said contract. The form of said bond to be approved by the Borough Solicitor.

The Town Council reserves the right to reject any or all bids.

Foreign corporation desiring to make bid should be registered in the office of the Secretary of the Commonwealth, as required by the act of April 22, 1874, and have bona fide resident agent in this State with a fixed office, and as a further precaution to the Borough of Steelton, the successful bidder, if foreign corporation, may at the option of the Town Council be required to empower some person or company satisfactory to the Town Council to accept service for said successful bidder during the term of the contract and bond.

(Signed) CHARLES P. FEIDT,
Borough Secretary.

Dredging

Greenville, Miss., May 30, 1912.

Sealed bids addressed to J. H. Nelms, Chairman, will be received at the office of the Engineer, Room 430, New Weinberg Building, Geenville, Miss., by the Board of Washington County Drainage Commissioners, to 12 M., July 15, 1912, for the construction of about nineteen miles of dredge ditch, ranging from twenty-six to fifty-six feet bottom; approximate quantities, 1,960,000 cubic yards. Also for the clearing of two natural streams aggregating about seventeen miles. Plans, profiles and specifications are on file at the office of the engineer and can be furnished on application. A certified check for $5,000 must accompany each bid. The right is reserved to reject any or all bids or to let the work as may appear to be for the best interest of the district.

THE WASHINGTON COUNTY DRAINAGE COMMISSIONERS.
B. B. GORDAN, Chief Engineer.
Greenville, Mississippi.

Paving

OFFICE OF BOARD OF CONTROL.
Norfolk, Va.

Sealed proposals will be received at this office until 12:30 o'clock, P. M. on the 18th day of July 1912 for regulating and paving Tenth Street from Granby Street to Llewellyn Ave., Colley Avenue from Westover to Armistead Avenue, Thirteenth, Fourteenth and Fifteenth Streets from Williams Avenue to Colonial Avenue, and separately Tunstall Avenue from Landing Street to Gibbs Avenue, all in the City of Norfolk, Va.

Instructions to bidders, specifications and bidding blanks can be had on applying to the City Engineer.

An approximate schedule of the work to be done is shown in the blank form of proposal attached to the specifications, which may be obtained from the City Engineer.

Each bid must be accompanied by a certified check in conformity to the requirements set out in the instructions to bidders.

Bids will be received for any of the following pavements:

Sheet Asphalt on a concrete foundation.

Warren's Bitulithic on a concrete foundation.

Bituminous Concrete on a concrete foundation.

Bituminous Macadam on a concrete foundation.

The right to reject any or all bids is reserved, and also the right to select either in whole or in part, such of the bids as the Board of Control and the City Engineer may deem advantageous to the City of Norfolk, Va.

THE BOARD OF CONTROL.
W. T. BROOKE,
City Engr.

Bridge Superstructure

TOWNS OF SCHROEPPEL AND LYSANDER, N. Y.

Sealed proposals, addressed to the Town Superintendent of Schroeppel and Lysander, New York, and endorsed "Proposals for Building the Superstructure of Six Spans of a Reinforced Concrete Bridge Across the Oswego River at Phoenix, N. Y., Removal of Old Bridge and Construction of Temporary Bridge," will be received by the Town Superintendents of Schroeppel and Lysander at the office of the Town Clerk, Phoenix, N. Y., until two o'clock P.M. of the 5th day of July, 1912, and at that time and place will be publicly opened and read.

The work covered by this Proposal will be found described in Paragraph 1 and other paragraphs of the Specifications and shown on the plans on file in the office of the Town Clerk of the Town of Schroeppel, at Phoenix, New York, and the office of Town Clerk of Lysander at Baldwinsville, N. Y. and in the offices of the County Superintendents of Oswego and Onondaga Counties.

W. B. POTTER,
Town Superintendent.
B. A. BARNARD,
Town Superintendent.
Dated this 11th day of June.

Road Known as Englewood Approach in the Palisades Interstate Park

Englewood Cliffs, Bergen County, N. J.

Sealed proposals for constructing the road known as Englewood Approach in the Palisades Interstate Park, at Englewood Cliffs, Bergen County, New Jersey, in accordance with the plans and specifications as prepared by WATSON G. CLARK, Civil Engineer, addressed to the Commissioners of the Palisades Interstate Park, No. 31 Nassau Street, New York City, and endorsed "Proposal for constructing Englewood Approach, Palisades Interstate Park," will be received by the Commissioners of the Palisades Interstate Park, at their office, at No. 31 Nassau Street, New York City, N. Y., until two P. M. on the Eighth day of July, 1912, which will at that time and place be publicly opened and read. Proposals shall be accompanied by money deposit in the form of a draft or certified check upon a National or State Bank or Trust Company in good credit within the States of New York or New Jersey, drawn to the order of the Treasurer of the Commissioners of the Palisades Interstate Park to the amount of Five Thousand Dollars, ($5,000.)

The Contractor to whom the contract is awarded will be required to furnish a satisfactory Bond for at least the full amount of the contract price and to execute the contract within ten (10) days from the date of the notice of the award.

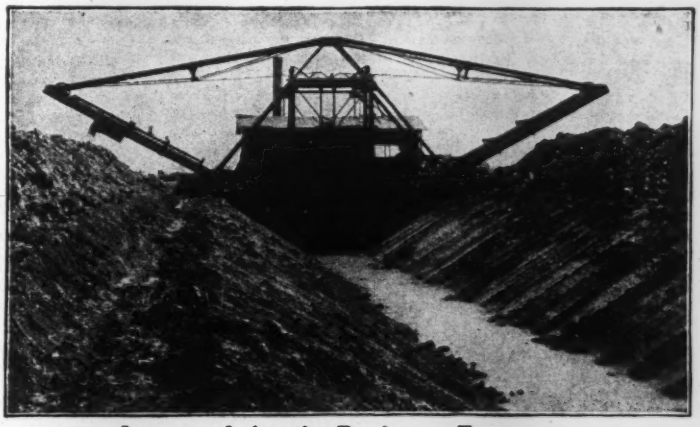
The Commissioners of the Palisades Interstate Park reserve the right to reject any or all bids and re-advertise the work before awarding the contract, if in their judgment, it is for the best interests of the Commission to do so.

For particulars as to nature and extent of the work to be performed, bidders are referred to the plans and specifications which will be on file and can be examined on and after June 17th, 1912, at the office of the Commissioners of the Palisades Interstate Park, No. 31 Nassau Street, New York City, and at the office of Watson G. Clark, C. E., 30 Church Street, New York City.

Bidders are required in making their proposals to use the blanks prepared for the purpose, which can be obtained at the office of the Commissioners, No. 31 Nassau Street, New York City, and at the office of Watson G. Clark, Civil Engineer, 30 Church Street, New York City.

By order
COMMISSIONERS OF THE PALISADES INTERSTATE PARK,
CHARLES W. LEAVITT, JR.,
Engineer of this Commission.
Dated June 12, 1912.

U. S. ENGINEER OFFICE, 337 Federal Building, Detroit, Mich., May 28, 1912—Sealed proposals for dredging Rouge River, Michigan, will be received at this office until 3 p.m., June 28, 1912, and then publicly opened. Information on application. C. McD. TOWNSEND, Col., Engineers.



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is possible at remarkably low cost by means of an Austin Drainage Excavator.

This Excavator Straddles the Old Ditch

and travels along it making a double across ditch cut down one bank, across the bottom, and up the opposite bank.

The Excavating Bucket is Guided by Templet

so that the ditch is trimmed to exact dimensions and shape—a deep sand bar or cave-in can be cut through or a thin layer of silt can be trimmed off, as the circumstances demand.

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F. C. Austin Drainage Excavator Company

Agents Wanted In Open Territory

Railway Exchange, Chicago, Ill.

Barge Canal

STATE OF NEW YORK.
OFFICE OF THE SUPERINTENDENT OF PUBLIC WORKS.

Albany, June 3, 1912.

NOTICE TO CONTRACTORS—Sealed proposals will be received by the undersigned at his office in the Capitol, Albany, N. Y., until twelve o'clock noon of Tuesday, July 2, 1912, at which place and hour they will be publicly opened and read, for improving the New York State Canals pursuant to the provisions of Chapter 147, Laws of 1903 and of the Amendments thereto, and pursuant to the provisions of Chapter 792 of the Laws of 1911, as follows:

CONTRACT NO. 8-A

Erie Canal—Section 2

For the construction of Lock No. 8, and the substructure of Dam No. 4 in the Mohawk River at Scotia, together with the replacement of defective concrete and the completion of protective paving, etc., for locks and dams at Rotterdam and Crane Village. Sheets 1 to 10 inclusive.

CONTRACT NO. 103

Oswego Canal—Section 1

For constructing a bridge over the Oswego River and Canal at Lock Street, Phoenix, N. Y. Sheets 1 to 6 inclusive.

Plans may be seen and detailed specifications, engineer's estimate of quantities, proposal blanks, form of contract and bonds required and other information for proposers may be had at the office of the Superintendent of Public Works at Albany, N. Y., at the office of the Assistant Superintendent of Public Works for the Middle Division at Syracuse, N. Y.; at the office of the Assistant Superintendent of Public Works for the Western Division at Rochester, N. Y.; and at the canal office, Spaulding's Exchange, Buffalo, N. Y.

Copies of detailed plans or drawings may be obtained from the State Engineer and Surveyor at Albany, N. Y., upon payment to him of the cost of producing them.

Monthly estimates will be paid of ninety per centum (90 per cent.) of the work done at the contract price. Every proposal for said work must be accompanied by a money deposit in the form of a draft or certified check upon some good banking institution in the city of Albany or New York, issued by a national or State bank in good credit within the State and payable at sight to the Superintendent of Public Works for five per centum (5 per cent) of the amount of the proposal.

The person whose proposal shall be accepted will be required to execute a contract and furnish bonds within ten days from the date of notice of award delivered to him or them in person or mailed to the address given in the proposal.

Upon execution of the contract and approval of bonds, the certified check or draft will be returned to the proposer unless the same shall have been presented for collection prior to such time, in which case the amount of the deposit will be refunded by the Superintendent of Public Works.

The deposits of bidders other than the one to whom the award of contract shall be made will be returned immediately after the award has been made.

The amount of bond required for faithful performance will be ten per centum (10 per cent.) of the amount of the estimated cost of the work according to the contract price, and an additional bond, known as the labor bond, in the sum of ten per centum (10 per cent.) of the amount of the estimated cost of the work according to the contract price, will be required as security that the contractor will pay in full at least once in each month all laborers employed by him upon the work specified to be done in the contract.

In the event that more than one surety company is offered as surety on said bonds, co-insurance only will be accepted.

Each proposal must be addressed to the Superintendent of Public Works, Albany, N. Y., and must be endorsed on the envelope with the name of the construction for which the proposal is made.

Award, if made, will be made to the person or persons whose proposal shall be lowest in cost to the State for doing the work, and which shall comply with all provisions required to render it formal. Before any award shall be made the lowest bidder will be required to satisfy the Superintendent of Public Works of his ability to provide suitable equipment and materials for the proper performance of the work.

The right is reserved to reject all proposals and readvertise and award the contract in the regular manner if, in the judgment of the undersigned, the interests of the State will be enhanced thereby.

DUNCAN W. PECK,
Superintendent of Public Works.

Main Intercepting Sewer

Fitchburg, Mass.

Sealed proposals will be received by the Board of Sewage Disposal Commissioners at their office, No. 352 Main street, Fitchburg, Mass., until 3 o'clock p.m. Thursday, July 11th, 1912, for the construction of Section 4 of the main intercepting sewer, covering the following work.

- 3,245 linear feet of earth excavation and building 36" concrete sewer.
- 75 cubic yards of rock excavation in trench.
- 210 square yards of brick masonry in sewer invert.
- 35 cubic yards of brick masonry in manholes.
- 827 cubic yards of concrete masonry in trench.
- 7,250 pounds of steel bars for reinforcing concrete.
- 15,000 feet B.M. lumber for sheeting, etc. left in place.

Each proposal for this work must be accompanied by a certified check for the sum of $2,500 drawn on a national bank or trust company established in the City of New York or some city in the State of Massachusetts, made payable to the City of Fitchburg, as security that if the proposal is accepted the contract will be entered into.

Plans and specifications may be obtained at the office of the Commission upon the deposit of $5.00, which deposit will be returned to any contractor when the plans and specifications are returned in good condition.

The right is reserved to reject any and all bids, or to accept any bid should the Commissioners deem it for the interest of the city so to do.

ARTHUR H. LOWE,
DAVID M. DILLON,
DANIEL A. BOYLE,
Board of Sewage Disposal Commissioners.
DAVID A. HARTWELL,
Chief Engineer.

Storm Water Sewers

Irvington, N. J., June 20, 1912.

Sealed proposals will be received by the Town Council of the Town of Irvington, at the Town Hall, Irvington, July 1st, at 8 o'clock P.M. or as soon thereafter as convenient, for the construction of the East End Storm Water Sewers.

The approximate amount of work to be done and material to be furnished is as follows:

- 2270 lineal feet of 48" lock joint reenforced concrete pipe furnished and laid.
- 623 lineal feet of 42" lock joint reenforced concrete pipe furnished and laid.
- 729 lineal feet of 33" lock joint reenforced concrete pipe furnished and laid.
- 32 lineal feet of 24" double strength vitrified sewer pipe furnished and laid.
- 270 lineal feet of 22" double strength vitrified sewer pipe furnished and laid.
- 230 lineal feet of 18" double strength vitrified sewer pipe furnished and laid.
- 363 lineal feet of 15" double strength vitrified sewer pipe furnished and laid.
- 45 lineal feet of 12" double strength vitrified sewer pipe furnished and laid.
- 300 lineal feet of 2'x10' re-enforced concrete culvert.
- 18 concrete manholes complete with iron head.
- 17 concrete catch-basins complete with concrete head.
- 5 cubic yards of concrete.
- 500 Cubic yards of earth excavation in widening and deepening stream.

A certified check or cash in the sum of $1000 and made payable to the Town of Irvington must accompany each proposal.

The work must be started within ten days from the date of the award and finished in seventy working days.

All proposals must be in sealed envelopes, addressed to the Town Council, Irvington, N. J. and endorsed "Proposal for East End Storm Water Sewer." The name of the bidder must also appear on the outside of the envelope.

Plans and Specifications can be seen at the office of the Town Clerk in the Town Hall, or at the office of I. J. Casey, Jr., Town Engineer, 1091 Clinton, Irvington.

The right is reserved by the Town Council to reject any or all bids.

I. J. CASEY, JR.,
Town Engineer.

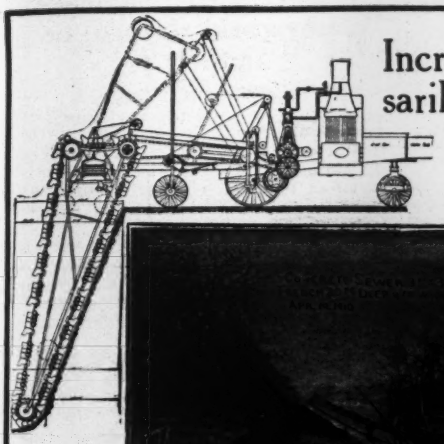
Great Miami River Improvement

Dayton, Ohio.

Sealed proposals will be received at the office of the Department of Public Service until 12 o'clock (noon) MONDAY, July 8, 1912, for 1,200,000 cu. yds. levee construction, including concrete retaining walls, sewers, riprap, 150 ft. steel truss bridge, piling and other work.

Detail drawings, profiles and cross-sections may be seen and General Plans and Specifications may be obtained at the office of the City Civil Engineer of the City of Dayton, Ohio.

CHAS. H. HOGLEN,
Director of Public Service.
CHAS. J. GROSS,
Secy.



Increase your earning capacity which will necessarily increase your profits by having a Parsons Trench Excavator on the job, a Machine which is reliable and upon which you can depend to be on the job all the time.

The first cost of a PARSONS is nothing when you take into consideration the INCREASED BUSINESS, and THE NECESSARILY INCREASED PROFITS that are yours when you have a PARSONS ON THE JOB.

Its **UNIVERSAL ADAPTABILITY** to all sewer work between twenty eight and seventy eight inches in width and twenty feet in depth is another factor greatly in favor of the PARSONS MACHINE. Then you have to take into consideration that it is not a great heavy, awkward piece of machinery, but on the contrary is comparatively light and easily moved from one place to another. Also all weight of machine is ahead of cut, there being absolutely no vibration within ten feet of newly excavated trench, consequently the solidity and compactness of the walls is in no way disturbed.

When you have a PARSONS you do not need a special machine to work in the alleys, as the entire width over all is only ten feet.

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THE G. W. PARSONS COMPANY Newton, Iowa

GRAVITY and PRESSURE FILTERS

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J. N. Chester, C. E.

THE NEW YORK CONTINENTAL JEWELL FILTRATION COMPANY
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ROEBLING EXPANDED METAL LATH
ROEBLING STANDARD WIRE LATH
THE ROEBLING CONSTRUCTION COMPANY
Metropolitan Tower New York

PAVING BLOCKS
We are one of the largest producers of Granite Blocks
We have recently laid from our fine Grained Granite, a pavement that is as smooth as asphalt.
GO LOOK AT IT
Fourth Ave. from 8th to 23rd St., New York City
Quarries:—Vinal Haven, Maine; Alexandria Bay, N. Y.
Our quarries are fully equipped with modern derricks and machinery.
We are prepared to make prices for export.
Can ship by rail or water promptly to any destination.
J. LEOPOLD & CO., 18 Broadway NEW YORK
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Garbage Disposal Plants
Dryers, Condensers and Percolators. Elevators, Conveyors and Tanks
Complete Plants for Large or Small Cities
THE C. O. BARTLETT AND SNOW CO.
CLEVELAND, OHIO, U. S. A.

TRENCH MACHINES
We sell and lease All Kinds of Hoisting and Conveying Machines for Trench Work.
Catalogue Sent Upon Request.
Carson Trench Machine Co., Boston, Mass.
BRANCH OFFICES: Rose Building, Cleveland; 318 St. James St., Montreal.

BLEACHING POWDER
(Chloride of Lime)
For Purifying Water and Sewage Disposal.
HOOKER ELECTROCHEMICAL CO.
50 Wall Street, New York City. Plant: Niagara Falls, N. Y.

Sewers

RE-ADVERTISEMENT
NOTICE TO CONTRACTORS.
Schenectady, N. Y.

Sealed proposals will be received by the Board of Contract and Supply of the City of Schenectady, until 2:30 p. m., Wednesday, July 3d, 1912, at the City Hall Annex, for the construction of Sanitary and Surface Water Sewers in the Second Ward. The approximate estimate of the work to be done is as follows:

8,000 Cubic Yards of Earth Excavation.
10,862 Cubic Yards of Rock Excavation.
340 Cubic Yards of 1-3-5 Portland Cement Concrete.
7,501 Lineal Feet of 8-inch Vitrified Tile.
4,490 Lineal Feet of 10-inch Vitrified Tile.
4,168 Lineal Feet of 12-inch Vitrified Tile.
5,048 Lineal Feet of 15-inch Vitrified Tile.
1,029 Lineal Feet of 18-inch Vitrified Tile.
282 Lineal Feet of 20-inch Vitrified Tile. Double strength.
36 Lineal Feet of 8-inch Cast Iron Pipe.
132 Lineal Feet of 10-inch Cast Iron Pipe.
168 Lineal Feet of 12-inch Cast Iron Pipe.
348 Lineal Feet of 16-inch Cast Iron Pipe.
890 Lineal Feet of Manholes, Vertical Measurement.
40 Catch Basins Complete.
68,000 Board feet of Lumber Sheathing.
68,000 Board feet of Lumber Foundations.

Plans and specifications may be obtained from the office of the City Engineer, W. Thomas Wooley, by making a deposit of Ten ($10.00) Dollars, which deposit will be refunded at such time as the plans and specifications shall be returned.

All bids must be made upon the printed pages which are part of this specification and enclosed in a sealed envelope directed to the Secretary of the Board of Contract and Supply and endorsed on the outside of the envelope "Proposal for Constructing Sanitary and Surface Water Sewers in the Second Ward."

Each bid must be accompanied by a draft or a certified check for Four Thousand ($4,000) Dollars issued by a National or State Bank, in good credit with the State of New York, and made payable to the "City of Schenectady."

The Board of Contract and Supply reserves the right to reject any or all bids.

FRED F. JOHNSON,
Secretary Board of Contract and Supply.

U. S. ENGINEER OFFICE, Newport, R. I., June 7, 1912. TO WHOM IT MAY CONCERN: Whereas navigation is obstructed and endangered by wrecks of schooners "LOIS V. CHAPLES" and "HANNAH F. CARLETON," in Nantucket Sound, Mass.; Notice is hereby given that unless otherwise removed within thirty days, it will be removed by the United States under authority of law. Sealed proposals for their removal will be received here until 12 M., July 9, 1912, and then publicly opened. Information on application. FREDERIC V. ABBOT, Col., Engrs.

U. S. ENGINEER OFFICE, Galveston, Texas, June 19, 1912—Sealed proposals for furnishing about 6,000 barrels American Portland Cement for Lock and Dam No. 8, Brazos River, delivered at Downs, Texas, will be received at this office until 12 M., July 19, 1912, and then publicly opened. Information on application. EARL I. BROWN, Major, Engrs.

Paving, etc.

OFFICE OF PAVING COMMISSION,
Baltimore, Maryland.

SEPARATE SEALED PROPOSALS, addressed to the Board of Awards, care of the City Register, will be received by him at his office in the City Hall until 11.00 A. M. Wednesday, July 3rd, 1912, to grade, curb and pave the following streets with materials as noted, all to be on a 6" concrete base:

CONTRACT NO. 32

Park Ave. from Lafayette Ave. to McMechen St.

Lanvale St. from Linden Ave. to Park Ave.

Lanvale St. from Madison Ave. to Eutaw Place.

McCulloh St. from Lafayette Ave. to North Ave.

Mulberry St. from Fulton Ave. to Monroe St.

Castle St. from Fayette St. to Madison St.

Richmond St. from Cathedral St. to Howard St.

Sheet Asphalt or Bituminous concrete .....33150 sq.yds.
Vitrified Block ..... 1330 " "
Certified Check $1800.00

CONTRACT NO. 33

East St. from Front St. to Low Street.

Front St. from Baltimore St. to Lombard St.

Granby St. from Jones Falls to Exeter Street

Low Street from East Street to Aisquith St.

Vitrified Block—9750 sq.yds.
Certified Check $600.00

The figures above represent the approximate quantities of the principal items appearing in the contracts.

Specifications and proposal sheets can be obtained upon application to the office of the Paving Commission, City Hall. A deposit of $5.00 will be required for a specification covering each contract. This will not be refunded unless a bid is filed.

The Board of Awards reserves the right to reject any and all bids. A certified check of the bidder on a clearinghouse bank, drawn to the order of the Mayor and City Council of Baltimore to the amount as recited above, must accompany each bid.

The successful bidder will be required to furnish bond and to comply with the City Charter respecting contracts.

By order of the Paving Commission.

R. KEITH COMPTON,
Chairman.

CHARLES A. EDEL,
Secretary.

Pumping Engine

Canton, Ill.

Sealed bids will be received by the Fire and Water Committee for a Meyer Gear Pumping Engine of 1,500,000 gallon capacity, up to two o'clock P. M., Saturday, June 29th, 1912.

The City reserves the right to reject any and all bids.

For specifications, address the City Clerk, Canton, Illinois.

JOSEPH WAUGH,
City Clerk.

U. S. ENGINEER OFFICE, 540 Federal Building, Buffalo, N. Y. June 20, 1912—Sealed proposals for furnishing and placing riprap stone and concrete deck on breakwater, Buffalo Harbor, N. Y. will be received at this office until 11 a.m. July 20, 1912, and then publicly opened. Information on application. J. G. WARREN, Colonel, Engrs.

Waterworks Improvements

NOTICE TO CONTRACTORS
Portsmouth, Ohio.

Sealed bids will be received by the Director of Service up to 12 o'clock noon July 18th, 1912, for furnishing the material and labor in connection with the following improvements to the Water Works System:—

Division 1. Brick Pumping Station, Chimney, Pump Well and Intake.

Division 2. Force Main from Pumping Station to Distributing Reservoir.

Division 3. Concrete Distributing Reservoir.

Division 4. Filtration Plant Complete, Including Sedimentation Basin.

Division 5. Pumping Machinery.

Bids for each Division must include bids for the Appurtenances pertaining thereto.

Each bid shall be accompanied by a bond subject to approval of the Service Director in the sum of 5% of the amount of the bid or a certified check for the same amount on some Solvent bank, made payable to David E. Edwards, City Treasurer, as a guarantee that if the bid is accepted a Contract for which a 50% bond must be given for its faithful performance, will be entered into within ten (10) days from the acceptance of the bid.

Plans may be seen and Specifications and blank forms of proposal, which must be used, may be procured at the office of the Director of Service, Portsmouth, O., or at the office of Witmer and Brown, Engineers, Chapin Block, Buffalo, N. Y.

The Engineers will furnish plans and specifications upon the payment of $25.00, which will be refunded upon the return of the plans in good condition.

Further information will be given upon application to John M. Williams, Director of Service, Portsmouth, Ohio, or Witmer and Brown, Engineers, Buffalo, N. Y.

JOHN M. WILLIAMS,
Director of Service,
Portsmouth, Ohio.

Water and Sewerage Construction

Carthage, N. C.

Sealed proposals will be received by the Board of Commissioners of the Town of Carthage, N. C. until July 16th, 1912, at 2 o'clock P. M. for the construction of a system of water works and sewerage in said Town.

Specifications can be obtained from the undersigned and plans and maps can be seen at the office of the Mayor of said Town.

A certified check equal to 10% of the amount of bid, drawn payable to the Treasurer of said Town will be required to accompany each bid.

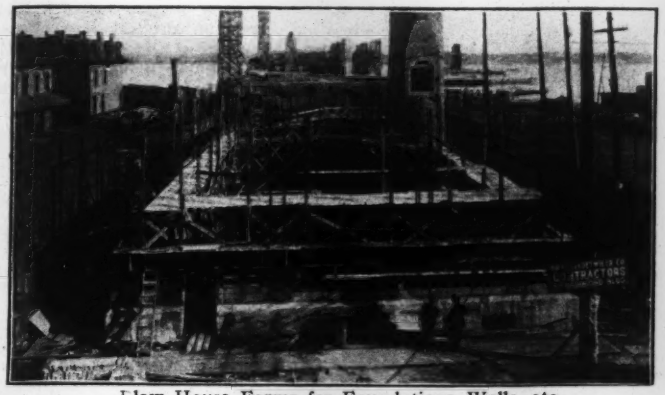
Bids should be addressed to the undersigned.

Right is reserved to reject any or all bids.

W. G. JENNINGS,
Secretary, Carthage, N. C.

U. S. ENGINEER OFFICE, Dallas, Tex., June 20 1912—Sealed proposals for dredging in section "b" Sabine-Neches Canal, Tex., will be received here until 12 M., July 20, 1912, and then publicly opened. Information on application. T. H. JACKSON, Maj., Engrs.

The Blaw System Building Contractors!



Llaw House Forms for Foundations, Walls, etc.

For Concrete Foundations and Walls, Blaw House Forms are ideal. They can be erected and shifted in but a fraction of the time it takes to move wood forms; they leave an absolutely smooth finish. They insure accurate construction, —**and they last.** You know how long wood forms last. Blaw forms are practically indestructible. Every contractor who is doing concrete wall work is throwing away good money unless he uses Blaw forms. These forms are *not* expensive.

Blaw Steel Forms For Every Purpose

Concrete Sewers, Aqueducts, Subways, Viaducts, Mine Shafts, Tunnels, Retaining Walls, Buildings, Silos, Houses, Culverts, Bridges, Chimneys, Manholes, Sidewalk, Curb and Gutter Work, etc. Concrete Pipe and Pole Molds. Steel Forms for Fireproofing Steel Frame Buildings for Concrete Columns, Beams, Girders.

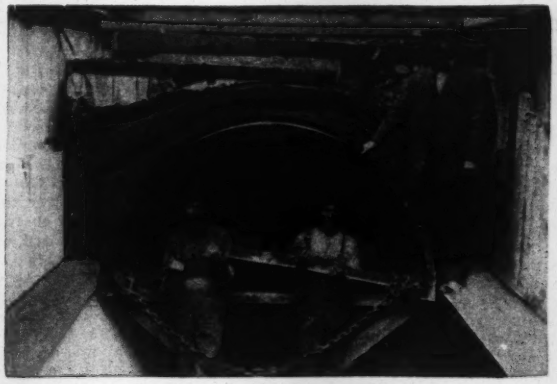
Let Us Design Your Forms. What Have You To Build?

Blaw Steel Centering Co., General Offices: Westinghouse Bldg., **Pittsburgh**

NEW YORK—165 Broadway CHICAGO—917 Ashland Block

O'Connor Collapsible Steel

Centering on a 72 inch Concrete Sewer Job



Note the simplicity of contraction. This is only one of the many features of the O'Connor Steel Centering for concrete and we should be glad to give you data which will save you money on your next concrete sewer, culvert or tunnel job.

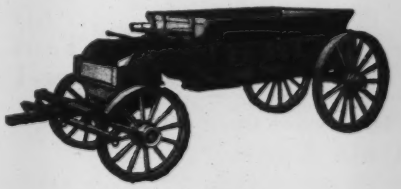
We have a favorable proposition on wood forms of the same design where more convenient.

Rights To Manufacture On Royalty Basis Will Be Disposed Of To Reliable Concerns In Unoccupied Territory.

WRITE FOR PARTICULARS

Hartford Paving & Construction Co.

703 Main Street, Hartford, Conn.



We Could "Get You"

if we could take you through our enormous factory and show you what is under the paint in Watson dumping wagons. It is very doubtful if we would even have to ask you for an order. You would insist on having Watsons. Many a man has done just that. This is not idle talk. Every week men are visiting our plant from various parts of the country and without exception they are amazed—not only at the size of it, but at the quality of material that is actually going into the Watson.

Do you want the printed matter?

Watson Wagon Co., Canastota, N. Y.

"The World's Largest Dumping Wagon Builders"

BRANCH OFFICES:
New York, 256 Broadway. Philadelphia, 604 Witherspoon Building. Pittsburgh, 1102 Farmers Bank Building. Chicago, 607 Security Building. Buffalo, 1411 Main Street.

Street Paving

Steelton, Pa.

Sealed proposals will be received by the Town Council of the Borough of Steelton, Pa., at the Council Chamber until 7:30 P. M. Monday, July 8th, 1912. To be opened at a regular meeting of the Town Council to be held at the said time and place for the sub-grading, paving and curbing of Harrisburg street between Lincoln Street and Northern Borough Line.

Plans, specifications, form of proposal and form of contract can be had from the Borough Secretary upon the payment of ten dollars, which will be refunded upon the return of the plans and specifications in good condition.

No proposal will be considered unless accompanied by certified check made payable to Leroy H. Sutton, Borough Treasurer, in the sum of $250.00 conditioned on the entering into by the successful bidder of a contract in accordance with the specification and form provided, and furnishing a bond with at least two sureties, or some surety company acceptable to the Town Council in the sum of $500.00 for the faithful performance of all the terms and conditions of the said contract. The form of said bond to be approved by the Borough Solicitor.

The Town Council reserves the right to reject any or all bids.

Foreign corporation desiring to make bid should be registered in the office of the Secretary of the Commonwealth, as required by the act of April 22, 1874, and have bona fide resident agent in this State with a fixed office, and as a further precaution to the Borough of Steelton, the successful bidder, if foreign corporation, may at the option of the Town Council be required to empower some person or company satisfactory to the Town Council to accept service for said successful bidder during the term of the contract and bond.

(signed) CHARLES P. FEIDT,
Borough Secretary.

Concrete Reservoir and Gate House

South Orange, New Jersey.

Sealed proposals endorsed "Proposals for Reservoir and Gate House" will be received by the Village Board of Trustees of South Orange, New Jersey, until 8 P.M., July 8, 1912, at the Village Hall.

Plans and specifications can be obtained at the Village Hall, or at the office of John J. Boyd, Consulting Engineer, No. 11 Broadway, New York City, by the payment of $10.00, the same to be refunded if the plans and specifications are returned within twenty (20) days, in good condition.

Each bid murt be accompanied by a certified cheque to an amount of $1,000, as a guarantee that the bidder will, if successful, execute within ten (10) days a satisfactory contract and furnish an acceptable Surety Company bond to the amount of $10,000, for the faithful performance of the contract.

Any information required by the bidders in regard to the plans and specification will be furnished on application to John J. Boyd, No. 11 Broadway, New York.

The Village Board of Trustees reserves the right to reject any proposal should it seem to be for the best interest of the Village so to do.

M. A. FITZSIMMONS,
Village Clerk.

Cast Iron Pipe, etc.

South Orange, New Jersey.

Sealed proposals endorsed "Proposals for Cast Iron Pipe" will be received by the Village Board of Trustees of South Orange, New Jersey, at the Village Hall, until 8 P.M., July 8th, 1912, for materials approximately as follows:—

4650 Feet 12" Cast Iron Coated Bell and Spigot Water Pipe,
48 Feet 10" Cast Iron Coated Bell and Spigot Water Pipe,
90 Feet 8" Cast Iron Coated Bell and Spigot Water Pipe,
7000 Lbs. of pipe specials,
4—12" Gate Valves,
2—10" " "
2— 8" " "
3—Valve boxes,
4— " standards.

All the above to be delivered, freight prepaid, to South Orange, New Jersey.

Specifications covering the above can be obtained upon application to John J. Boyd, Consulting Engineer, No. 11 Broadway, New York City.

Each bid must be accompanied by a certified cheque for $500. as a guarantee that the bidder will if successful execute within ten days a satisfactory contract and furnish an acceptable Surety Company bond to the amount of $1500. for the faithful performance of the contract.

The Village Board reserves the right to reject any proposals should it seem to be for the best interest of the Village so to do.

M. A. FITZSIMMONS,
Village Clerk.

Ten-inch Cased Well, One 50,000 Gallon Steel Tank on a 120 ft. Tower, Engines, Deep Well Pump and Building

Morton Grove, Ill.

Sealed proposals are invited and will be received at the office of the Village Clerk, Morton Grove, Ill., until the hour of opening the same as hereinafter set forth, for the construction of a 10-inch cased well, one 50,000 gallon steel tank, 120 ft. steel tower, engines, deep well pump and building. Bids must be accompanied by a certified check on a responsible bank doing business through the Chicago Clearing House, or equivalent, equal to 10% of the amount of said bid, which may be obtained from the Village President, August F. Poehlmann, or the Village Clerk.

Said proposals or bids shall be opened, examined and publicly declared by said Board at a meeting thereof to be held in the Village Hall in the Village of Morton Grove, at the hour of 8 o'clock, P. M., on the 2nd day of July, A. D., 1912. For further information, address M. J. Lochner, Village Clerk.

The right is reserved to reject any and all bids.

AUGUST F. POEHLMANN,
Village President,
Morton Grove, Ill.

U. S. ENGINEER OFFICE, Galveston, Texas, June 19, 1912—Sealed proposals for crushed rock or gravel, delivered at Downs, Texas, will be received at this office until 12 M. July 19, 1912, and then publicly opened. Information on application. EARL I. BROWN, Major, Engr.

Sewers

NOTICE TO CONTRACTORS

Watertown, N. Y.

Sealed proposals for the construction of the North Side Sanitary Trunk Sewer will be received at the office of the City Engineer at the City Hall, Watertown, N. Y., until 8 P. M., Friday July 5th, 1912, when they will be publicly opened and read at a meeting of the Board of Public Works. The number of feet of sewer to be constructed is approximately as follows:

236 lineal feet of 45 inch sewer
2704 lineal feet of 36 inch sewer
540 lineal feet of 30 inch sewer
1535 lineal feet of 24 inch sewer
1551 lineal feet of 18 inch vitrified tile sewer
1053 lineal feet of 15 inch vitrified tile sewer
2417 lineal feet of 12 inch vitrified tile sewer
31 manholes

Plans and specifications for the above mentioned improvement are open for public inspection and may be seen at the office of the City Engineer from whom blank proposals can be obtained.

The Board of Public Works reserves the right to reject any or all bids received.

A draft or certified check for two thousand five hundred dollars made payable to the President of the Board of Public Works must accompany each bid.

BOARD OF PUBLIC WORKS.
By E. W. SAYLES,
City Engineer.

Dated June 21st, 1912.

Water Purification Plant

Dallas, Texas.

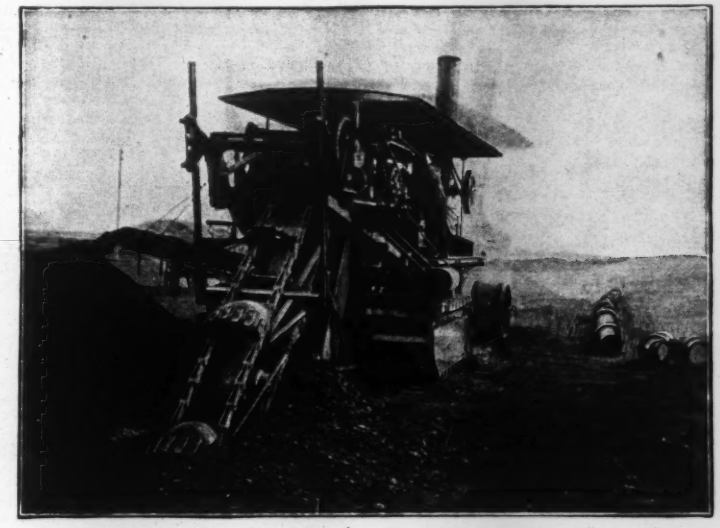
Bids will be received at the office of the City Secretary, Dallas, Texas, until July 17, 1912, 2 P. M., for building and constructing a Water Purification Plant at Dallas, Texas, on the site known as the Turtle Creek Pumping Station, situated on the switch of M. K. & T. Ry., about one and one-half miles from the City Hall.

A deposit of $50.00 (Fifty Dollars) will be required to get a set of plans and specifications. The check for $50.00 will be returned to bidders upon return of plans and specifications in good condition. Each bid must be accompanied with a certified check for Fifteen Thousand Dollars, payable to the City of Dallas, said checks to be returned to the unsuccessful bidders upon the award of contract and to the successful bidder after the contract and bond is executed and accepted by the City of Dallas. A bond in the sum of One Hundred Thousand Dollars must be furnished by the successful bidder, executed by an approved Surety Company, and by a resident of Dallas County, Texas.

Plans and specifications can be secured at the office of Jas. H. Fuertes, 140 Nassau St., New York, or at the office of the City Secretary, Dallas, Texas.

All bids must be addressed to J. B. Winslett, City Secretary, Dallas, Texas. Mark all envelopes "Bids on Water Purification Plant." The City of Dallas reserves the right to reject any or all bids.

U. S. ENGINEER OFFICE, 337 Federal Building, Detroit, Mich., June 22, 1912—Sealed proposals for Machinery and Valves for New Lock at St. Marys Falls Canal, Sault Ste. Marie, Mich., will be received at this office until 3 p.m., July 25, 1912, and then publicly opened. Information on application. C. McD. TOWNSEND, Col., Engrs.



The Liberal Use of Replaceable Bushings

in Austin Trench Excavators removes all wear from the main structure and confines it to inexpensive parts that are easily renewed.

Manganese Steel is used for all bushings and pins, thus reducing wear and making the renewal of even these minor parts a rare thing.

One machine in 1911 excavated 13 miles of trench 9 to 14 ft. deep and 27 to 39 in. wide without the renewal of a single bushing or pin.

This is not an unusual record—in fact chain repairs are so few on an Austin Drainage Excavator that they are almost negligible.

Another machine in 1910 dug 25 miles of trench through very bad stony ground with a repair bill less than 2 per cent. of the original cost.

This is not the whole story for during the succeeding season this same machine worked continuously and the repair bill was between 5 and 6 per cent only of the original cost.

The gain in economy coming from these facts is not merely small repair bills. The money earning power of the machine is not reduced by delays waiting for repairs.

A two-hour tie-up in an eight hour day means 25 per cent loss of trench dug in addition to the repair bill.

(Send for Catalog No. 102-A)

F. C. Austin Drainage Excavator Company

Agents Wanted In Open Territory **Railway Exchange, Chicago, Ill.**

Bridge

Brainerd, Minn.

Sealed bids will be received at the office of the County Auditor of the County of Crow Wing, at the County Court House, in the City of Brainerd, Minnesota, until three o'clock P.M. July 13, 1912, for building a bridge on highway across Crow Wing River, between sections 32 and 33, township 133 north, of range 29 west, 5th P.M. in the Counties of Cass and Morrison, State of Minnesota. Such bridge to be 283 feet long, three span, sixteen foot roadway clear, floor of bridge 20 feet above river bed at center, foundation constructed of concrete abutments and tubular steel piers, according to plans and specifications now on file with the said County Auditor of Crow Wing County. At the same time and place bids will be received from any bidder on his own plans and specifications for a bridge of equal service and durability at the same location.

Each proposal must be accompanied by certified check to the amount of ten per cent of his bid, payable to the Chairman of the Committee hereinafter named. The Committee representing the Counties of Crow Wing, Cass and Morrison, reserves the right to accept or reject any and all bids and proposals.

J. A. ERICKSON,

Chairman of Committee representing Crow Wing, Cass and Morrison Counties, Minnesota.

Contract 45-D—Drainage Canal Siphon

(CHANGE OF DATE)

OFFICE OF SEWERAGE AND WATER BOARD, ROOM 508 CITY HALL ANNEX.
New Orleans, La., June 18th, 1912.

Sealed proposals wil be received by the Secretary, at the office of the Board, 508 City Hall Annex, until 12 o'clock M., Saturday, August 24, 1912, for the construction of a reinforced concrete siphon under the New Basin Navigation Canal at Broad street, to be known as contract 45-D.

A certified check on a New Orleans bank, for $1,000, deposited in accordance with the terms of the specifications, will be required of each bidder.

A surety company bond, in a company doing business in the State of Louisiana, for an amount equal to 25% of gross amount of contract will be required of successful bidder.

The right is reserved to reject any or all bids.

F. S. SHIELDS, Secretary.
GEO. G. EARL,
General Superintendent.

TREASURY DEPARTMENT, Office of the Supervising Architect, Washington, D. C., June 21, 1912—Sealed proposals will be received in this office until 3 o'clock p. m. on the 2d day of August, 1912, and then opened, for the construction (including plumbing, heating apparatus, gas piping, electric conduits and wiring, and interior lighting fixtures) of the extension, remodeling, etc., of the United States post office and courthouse at Charlotte, N. C. The extension is two stories and basement, stone faced, of fireproof construction (except roof), and has a ground area of approximately 12,600 square feet. Drawings and specifications may be obtained from the custodian of site at Charlotte, N. C., or at this office, at the discretion of the Supervising Architect. JAMES KNOX TAYLOR, Supervising Architect.

Street Improvements

Bayonne, N. J.

NOTICES TO CONTRACTORS
SEALED PROPOSALS

WILL BE RECEIVED BY THE COUNCIL of the City of Bayonne, N. J., at a meeting to be held in the City Hall, on

TUESDAY JULY 2nd, 1912
at 8 o'clock p.m.

for all the labor and material required for the improvement of the following streets, viz:—

West 7th Street, from Broadway to Hudson Boulevard. There will be required about 1800 lin.feet of new blue stone curb, 1600 squ.yards macadam pavement together with other appurtenances. The amount of bond required is $5000. The time allowed for the completion of the work is 80 days.

Hobart Avenue, from 3rd Street to Oak Street. There will be required about 9600 squ. yards Asphalt block paving on concrete, 4000 lin. feet new blue stone curb, together with other appurtenances. The amount of bond required is $10,000. The time allowed for the completion of the work is 80 days.

15th Street, from Broadway to Avenue E. There will be required about 2400 squ. yards Asphalt paving on concrete, about 1400 lin. feet of new blue stone curb and about 52,000 squ.feet of new blue stone flag with other appurtenances. The amount of bond required is $3000. The time allowed for the completion of the work is 35 days.

50th Street, from Broadway to Avenue C. There will be required about 2350 squ.yards of Asphalt paving on concrete, about 780 lin. feet of new blue stone curb, and about 700 squ.feet of new blue stone flag with other appurtenances. The amount of bond required is $3000.00. The time allowed for the completion of the work is 35 days.

West Seventeenth Street, from Avenue C to Hudson Boulevard. There will be required about 2275 squ. yards Asphalt paving on concrete, about 1350 lin. feet blue stone curb together with other appurtenances. The amount of bond required is $3000. The time allowed for the completion of the work is 75 days.

Linnett Street, from Avenue E to Orient Street. There will be required about 1280 squ. yards of Granite block paving on concrete, and about 300 lin. feet blue stone curb, together with other appurtenances. The amount of bond required is $3000. The time allowed for the completion of the work is 35 days.

Avenue E, from Broadway to the northerly line of Fifty-second Street. There will be required about 64900 squ. yards Asphalt pavement on concrete, about 23000 lin. feet of new blue stone curb, about 29200 squ. feet new concrete flag, about 15700 squ. feet new blue stone flag together with other appurtenances. The amount of bond required is $50,000. The time allowed for the completion of the work is 110 days.

All bids must be on the regular forms provided for the purpose.

Plans and specifications for the work are on file in the office of the City Surveyor where blank forms of proposals or any further information may be obtained.

The Council reserves the right to reject any or all bids.

By order of the Council.
WM. P. LEE, City Clerk.

Notice to Engineers

Sealed bids, addressed to the chairman of the Committee, will be received until 5:30 P.M. July 8th, 1912, for making all necessary surveys and mapping for a complete Block Book of the City of Greenville, S. C., in accordance with the specifications adopted.

Each bid must be accompanied by a certified check made payable to the Chairman for $250.00.

The City shall reserve all rights of the said book and the notes.

The right is reserved to reject any or all bids.

Specifications can be seen at the Office of the City Engineer, or will be mailed upon application to him.

Committee,
CHAS. F. HARD, Chairman.
C. S. WEBB.
W. C. BEACHAM.
C. P. BALLENGER,
City Engineer.

Paving and Sewer

Odell, Ill.

Sealed proposals will be received until 2 P. M. Monday July 1st, 1912, and then publicly opened in the Council Chamber of the Village of Odell, Ill., for approximately: 13,000 square yards vitrified brick paving; 7,000 lineal feet gravel concrete curb; 3000 lineal feet 9-inch to 15 inch tile pipe sewer. Bids must be made on a form which will be furnished for the purpose, sealed and addressed to the President of the Board of Local Improvements, and no bid will be considered unless accompanied by cash (or check payable to the President of said Board and certified by some responsible bank) to an amount which shall not be less than ten per centum of the aggregate amount of such bid. Bidding blanks and specifications may be had and plans may be seen at the office of the Village Clerk, Odell, Illinois, or at the office of the AETNA ENGINEERING BUREAU, 17 North La Salle Street, Chicago.

THEODORE TRECKER, Clerk,
Village of Odell, Ill.

U. S. ENGINEER OFFICE, 540 Federal Building, Buffalo, N. Y., May 29, 1912—To whom it may concern: Whereas navigation is obstructed and endangered by wreck of the steel steamer "W. C. Richardson" sunk in Lake Erie about one and five eighths miles outside of breakwater, Buffalo Harbor, N. Y.: Notice is hereby given that unless otherwise removed within thirty days the wreck will be removed by the United States under authority of law. Sealed proposals for its removal will be received at this office until 11 A.M. June 29, 1912, and then publicly opened. Information on application. J. G. WARREN, Colonel, Engrs.

PROPOSALS FOR LEVEE WORK. Mississippi River Commission, Third District. U. S. Engineer Office, Vicksburg, Miss., June 10, 1912—Sealed proposals for constructing about 1,600,000 cubic yards of earthwork in this district, will be received at this office until 11 o'clock, A.M., Standard Central Time, July 11, 1912, and then publicly opened. Information on application. J. A. WOODRUFF, Major, Engrs.

FOR ADDITIONAL PROPOSAL ADVERTISEMENTS SEE PAGE 59

This advertisement has appeared in Engineering News but we repeat it because we want the message it bears to stick in your mind.

Russell Sage Wore Hand-me-down Clothes—and Commanded Millions

This is a preachment to those advertisers who measure the value of an inquiry by the paper it's written on.

And to those who waste-basket the best of them unfollowed.

An inquiry of any nature from any man who pays the price and takes the time to read a good engineering paper is worth the real attention of any advertiser in that paper.

Does he get it? Not always, on your life.

If recent reports from our advertising salesmen be true, some advertisers are sitting in high judgment on the inquiries they receive, deciding that *this* postcard is unworthy or *that* letter is from too remote a point to bother with.

Even the most promising-looking inquiries are getting only a perfunctory reply, a catalog—and oblivion.

Inquiries do not represent the total results of advertising any more than "two" represents the sum of ten and ten, but—

An inquiry is the crystallized result of the impression you've made on some man interested enough in your product to want to know more.

He's a "prospect," if ever there was one, and indifference in your treatment is the sure way to send him to a competitor.

Suppose he *does* write on a postcard—you wouldn't refuse to sell him goods because you didn't like his brand of union-suit, would you? As a matter of fact, prospective buyers are not over-careful as to *how* they inquire. They are under no obligation to you.

Suppose his handwriting is *not* a model of chirography—remember that Horace Greeley's hen tracks could be deciphered by only one compositor, but when they got into print they made masses move.

Suppose he *is* out of your beaten track of sales—your follow-up might make him a *believer* in your product. Maybe he'll be nearer home some day. You're going to stay in business—win him for the future.

Fact is, the real buyer of your product is not necessarily an habitué of the board room. He may be that square-jawed, gruff-voiced individual out yonder bossing a hoisting job. Don't ignore him any more than you'd buy an automobile solely for that quality of the upholstery. Regard *every* inquiry as a good one and then do this:

Write a *sales* letter—an interesting, courteous, convincing sales letter. Don't be afraid to make it long enough to adequately cover your subject. The inquirer is *interested.*

Then write others until you have told your story, always basing the subject matter on the fact that you are giving the prospect more information.

If the matter ripens sufficiently put a salesman on the job and help him out by good letters from the office.

There are many forms of follow-up, any one of which is good. If you want some hints and helps for a definite one for your purpose address the Make-It-Pay Department. No charge is made for suggestions.

But don't ignore this fact if you want to make your advertising pay:—

All inquiries are not good, but none is so bad as to be disregarded.

Engineering News
505 Pearl Street
New York

Wants

Rate: 20 cents per line per insertion. Five words count as a line. Add four words for keyed address. Minimum charge 40 cents. Remittance must accompany order.

Mechanical and Electrical Engineers

MECHANICAL ENGINEER, technical graduate, wide experience structural steel, power-house design, water-tube boilers, economizers, stoker, furnace and stack construction, expert estimator, wishes responsible position. Box 1022, Eng. News.

MECHANICAL ENGINEER, college graduate, speaks French and some English, four years' drafting and two years' shop experience, desires position with reliable concern; will go anywhere; moderate salary. Box 1034, Eng. News.

MECHANICAL ENGINEER, age 26; broad experience in office and field in charge of mechanical, electrical power and construction work with large industrial concerns; expert designer. Box 1035, Eng. News, 1144 Monadnock Block, Chicago.

Civil Engineers

GRADUATE Civil Engineer, with following experience, open for engagement: Railway, maintenance and construction, track elevation, water supply pumping, long pipe lines, sewerage; understands thoroughly the design of railway terminals, hydroelectric and steam electric power plants, electric traction, irrigation work, reports, reconnoissance, etc.; was Assistant Professor of Civil Engineering; held important position with two large railroad systems. Box 9, Eng. News.

GRADUATE CIVIL ENGINEER, competent estimator, desires responsible position where executive ability and thorough knowledge and experience in all branches of structural design and building construction in office and field are requisite. Box 475, Eng. News.

HYDRAULIC ENGINEER, Swiss; 12 years' experience office and field here and abroad. Box 928, Eng. News.

CIVIL ENGINEER, technical training; nine years' experience, plans, specifications and superintendence; general construction and engineering work; position with general contractor preferred. Box 963, Eng. News.

GRADUATE CIVIL ENGINEER, 35; Mem. Am. Soc. C. E.; 12 years responsible charge of steam and high-speed electric railroad location and construction, main line and suburban; heavy grading, foundations and masonry; concrete, plain and reinforced; bridges, sewers, paving, buildings, etc.; open for engagement soon. Box 962, Eng. News.

YOUNG ENGINEER, 27, technical education, six years' experience in railway location, construction and maintenance of way, at present in charge of double section railway construction, Canada, desires foreign experience either Southern or Asiatic; best references. Box 936, Eng. News.

MANAGING, INVESTIGATING or construction engineer, 35; civil engineer graduate; wide experience railroad, municipal, industrial plant, reinforced-concrete and building construction; also efficiency methods, costs, contract and specification writing, appraisals, etc.; references. Box. 935, Eng. News.

GRADUATE CIVIL ENGINEER, now employed; six years' experience as draftsman, resident engineer and superintendent on surveys, dam, factory and house construction. Box 988, Eng. News.

EXPERIENCED ENGINEER—Position wanted by graduate engineer with eight years' high grade experience on various classes of work; prefer permanent position with future prospects; salary, fifteen hundred a year to start. Box 1011, Eng. News.

GRADUATE CIVIL ENGINEER, with 13 years' varied experience, specialty railroad and highway location, construction, maintenance, valuation and reports; last five years in Mexico, at present in New York, would like to join staff of a construction company or work for corporation. Box 1004, Eng. News.

GRADUATE ENGINEER, Assoc. M. Am. Soc. C. E., 43; 12 years' experience location, construction and heavy foundation work for railways; also general surveys; responsible position only. Box 1041, Eng. News.

CIVIL ENGINEER GRADUATE, fair draftsman, desires position; moderate salary; location immaterial. Box 1039, Eng. News.

CIVIL ENGINEER (26) desires to change position; four years' experience surveying, concrete construction, railroad location and construction, masonry work; can furnish best of reference. Box1033, Eng. News.

GRADUATE ENGINEER, 12 years railroad location, construction and maintenance, three structural steel; thorough field or office man; now located in New York. Box 1044, Eng. News.

GRADUATE ENGINEER, 29, Assoc. M. Am. Soc. C. E.; experienced field and office, sewers, sewage disposal, roads, pavements, municipal, mill buildings, concrete, surveys, contracting; complete field outfit; present location, New York State; personal interview. Box 1042, Eng. News.

ENGINEER, technical, 13 years surveys, railroad maintenance, construction of bridges and buildings; excellent designer railway structures. Box 1030, Eng. News.

CIVIL ENGINEER open for engagement; experienced in superintending concrete construction; six years' experience on heavy construction as inspector, instrumentman, superintendent; age, 26, married. C. E. Anderson, 24 Dean Place, Poughkeepsie, N. Y.

Bridge and Structural

STRUCTURAL ENGINEER, 29, six years' experience in industrial and power-plant design, desires change of location; at present employed by large New York corporation designing new smelter; correspondence solicited with parties desiring experienced man. Box 979, Eng. News.

STRUCTURAL ENGINEER desires position with some first class contractor, architect or engineer, New York City preferred. Box 1010, Eng. News.

ENGINEER (Cornell), 13 years bridges and buildings; first-class designer. Box 1029, Eng. News.

Surveyors

TECHNICAL GRADUATE, 2½ years railroad and municipal work; instrumentman or rodman. Box 937, Eng. News.

SURVEYOR—Nine years' experience in field and office; have instruments. Box 983, Eng. News.

RODMAN AND CHAINMAN; practical and theoretical; knowledge in surveying; salary immaterial. Box 1038, Eng. News.

RODMAN, chainman and map draftsman, experienced, technical education; salary no object. Box 1053, Eng. News.

Draftsmen

DRAFTSMAN, three years with architects, three years steel detailing on buildings, desires change. Box 1025, Eng. News.

DRAFTSMAN, tracer, technically trained, high school education, desires civil engineering position. Box 1026, Eng. News.

DRAFTSMAN, tracer, technical training, desires position, civil engineering line. Box 1027, Eng. News.

AS CHIEF DRAFTSMAN or structural designer; experience: railroad structures, office and industrial building design, steel and reinforced concrete; have had charge of field and office work; technical graduate; salary, $175 per month; executive position preferred. Box 1056, Eng. News.

Superintendents etc.

CONTRACTOR'S ENGINEER, Assoc. M. Am. Soc. C. E., technical graduate; wide experience structural steel, reinforced concrete, foundations, all branches building construction and estimates; good executive; minimum salary $4000, or reasonable guaranteed drawing account, plus share of results; New York or Chicago interview. Address, giving full particulars. Box 638, Eng. News.

ENGINEERING SALESMAN, eight years' experience on general construction, engineering and promotion; college graduate; open for position with contractor, paving company or concern manufacturing structural material; best references. Box 977, Eng. News.

STRUCTURAL ENGINEER desires position, designer with responsible firm buildings and bridges. Box 1009, Eng News.

ROAD EXPERT—Position wanted as engineer in charge or superintendent of construction for any and all kinds of road work, boulevard, landscape work bituminous or concrete work; college graduate; eight years' experience; best references. Box 1013, Eng. News.

CONTRACTOR'S ENGINEER and estimator open for engagement after August 1; experienced as designing engineer and superintendent of construction; technical graduate. Box 1003, Eng. News.

STRUCTURAL DESIGNER desires position with architect, engineer or contractor, mill, office and loft buildings references; interview. Box 1008, Eng News.

LANDSCAPE ENGINEER—Engineer, college graduate, eight years' experience, wants position with private estate or development company; best references. For details address Box 1012, Eng. News.

THEW SHOVEL RUNNER would like position immediately. Address A. Brazos & Sons, Middletown, Conn.

ESTIMATOR and engineer, 14 years' experience designing, estimating and detailing for structural and ornamental iron works, open for engagement. Box 1045, Eng. News.

ESTIMATOR IN CHIEF with firm of builders; structural engineer and business getter; age 40; open for position. Box 1048, Eng. News.

WANTED—Position as instructor in engineering college or with water power development company; two years, topographic branch, U. S. Geological Survey; five years, U. S. Engineering Department; B. S. in Civil Engineering; Junior, Am. Soc. C. E.; Junior Engineer, U. S. Engineering Department. Box 1050, Eng. News.

SUPERINTENDENT desires position; employed, but desires to connect with firm doing heavy construction; age 31; experienced as carpenter, millwright, estimator and superintendent; well posted on reinforced concrete building design; can bring two first-class foremen or assistants; will go anywhere in United States, Canada or West Indies; a position of strenuous responsibility desired. In reply, give location, size of job and salary. Box 1051, Eng. News.

POSITION WANTED as foreman; experienced in bituminous construction on state roads and municipal work. Box 1054, Eng. News.

SALES ENGINEER wishes to make a change; broad experience with both pumps and air compressors; have had both road and office experience. Box 1043, Eng. News.

YOUNG MAN, graduate, over two years' experience structural and charge of highway construction; employed at present; desire change; location immaterial. Box 1019, Eng. News.

SUPERINTENDENT for building construction and who has had a number of years' experience in reinforced-concrete form work; open for position. Box 1020, Eng. News.

Situations Open

EXPERIENCED DRAFTSMEN wanted on structural-steel work for buildings. Apply by mail, giving age, nationality, education, experience and salary expected. Post & McCord, 44 East 23d St., New York City.

WANTED—Engineering salesman of experience and ability with salary based on results produced; answer giving experience, etc. Box 942, Eng. News.

WANTED—Competent engineer to take active interest in established incorporated company selling castings, steel plate and other engineering construction; answer giving experience, salary expected and amount of money able to invest. Box 943, Eng. News.

WANTED AT ONCE—Draftsman in freight-car shop in New England States; man with experience in shops as well as drafting room preferred; state experience, age and salary expected. Box 944, Eng. News.

SALES ENGINEER: familiar with reinforced concrete and structural steel design for office work in Ohio; excellent opportunity for young man with few years' experience in this line. Box 947, Eng. News.

SUPERINTENDENT for charge of general building work, New York City; one with reinforced-concrete experience; answers please state age, references and compensation desired. Box 907, Eng. News.

WANTED, at once, by shop in Central West, one or two good structural draftsmen, capable of detailing and checking structural and bridge work; give experience, age, salary required and earliest date can report for duty. Box 952, Eng. News.

PRACTICAL sheet metal draftsman wanted to inspect and design contractor's apparatus, must positively be experienced in best sheet metal practice. Box 997, Eng. News.

MECHANICAL draftsman wanted, one familiar with design of contractor's machinery, hoists, concrete mixers, steel towers, or similar devices; good salary to the right man. Box 996, Eng. News.

WANTED—Experienced time and cost keeper on building construction; write stating age, experience, and for what employer; wages $18. Box 1037, Eng. News.

WANTED—Structural foreman for small structural shop, Detroit; good chance for active, ambitious subforeman seeking more responsibility; replies must state age, experience, references and wages wanted. Box 1036, Eng. News.

WANTED—Foreman to take charge of concrete finishing work on concrete buildings and concrete floors; steady job to the right man; state experience, references and salary expected. Apply Fred T. Ley & Co., Springfield, Mass.

WANTED—Experienced detailers on iron stairs, elevator fronts and marquise. Apply by letter stating experience, age, nationality, salary required and when available, to the Chesapeake Iron Works, Baltimore, Md.

WANTED—Instructors in mechanical engineering and in mechanical drawing at an Eastern institution; applicants must be graduates of technical schools, preferably with one or two years' practical experience; give full details of education, experience and salary expected. Box 1024, Eng. News.

WANTED—At once, high-class, skilled, neat draftsmen; one experienced on plans for water-works, pipe work and mechanical filtration; quick two months' engagement near New York, to work on designs and working drawings; also one less experienced to assist above man; state experience, references and salary expected. Box 1049, Eng. News.

CIVIL ENGINEER wants man to assist in designing steel work for buildings; state experience, salary. Box 1052, Eng. News.

WANTED—Several structural draftsmen and checkers. Apply New England Structural Co., Everett, Mass.

Miscellaneous Wants

UNUSUAL OPPORTUNITY with option of investment for mechanical engineer, comoining engineering knowledge with some executive and selling ability; company located in Buffalo, N. Y., manufacturing and selling contractors' machinery and equipment, also specialties for steam, water, gas, oil and air. Box 1032, Eng. News.

MACHINE SHOP AND SHIP YARDS, ATTENTION—Practical engineer, 36, American, 15 years' experience, who has specialized on dredging machinery, also general designer including engines, boilers, elevators, conveyors, marine engines, hulls, auxiliaries, etc., conversant with best modern methods, good executive and systemizer, would like to hear from a successful and progressive concern who would take up the building of dredging machinery and complete dredges; prospect for immediate work. Address at once if interested, Box 1023, Eng. News.

GENERAL CONTRACTOR of railroads and public utility works, with very wide financial experience and ability, prepared to aid materially in the financing and construction of some strong enterprise now offers his services and is open for a reliable proposition; please submit complete data and requirements with first letter to receive attention. Box 1028, Eng. News.

An experienced and high-classed young sales engineer located in New York and now handling big business desires a connection with a few high-classed contractors' and railway equipment and supply houses; either a straight commission or branch office basis agreeable; only lines of highest type will be considered; if you have such a proposition please advise fully; would like a connection with a reputable steel foundry. Box 1031, Eng. News.

AN ENGINEER, with long experience in selling mining and general machinery, four years in Mexico, excellent knowledge of Spanish, desires position as sales representative of large machinery company either in Mexico or other Spanish-speaking country; best references. Box 1047, Eng. News.

EXPERIENCED MAN would like to go in partnership with any contractor on grading or railroad work. Box 1055, Eng. News.

TO ENGINEERS AND MANUFACTURERS—Temporary or permanent offices completely furnished can be rented in the most desirable building in New York, at prices ranging from $15 to $40 per month; all facilities, private phone, stenographer, typewriters, all engineering journals, directories, etc. Address Manufacturers' Library, Hudson Terminal Building, 50 Church St.

BACK COPIES WANTED—We are greatly in need of the following issues of Engineering News: Jan. 11, 1912, and May 2, 1912. For either of these copies returned to our New York office, 505 Pearl St., by a subscriber, we will extend his subscription one month. Write your name on the wrapper containing copies.

WANTED — Machinery manufacturer with good equipment and foundry, or near good foundry, who is able to manufacture and finance a line of centrifugal and turbine pumps; this is a growing and profitable business with an established trade and foreign connections. Box 992, Eng. News.

TEN TON standard macadam roller wanted; write best cash price and description to Box 986, Eng. News.

CONTRACTOR with singular ability in securing and executing profitable public and private construction work, desires to meet graduate engineer or promoter who can furnish or interest capital in the formation of a construction company to secure large profitable sewer contracts in the vicinity of New York. Box 1014, Eng. News.

Agencies and Bureaus

WANTED—Draftsmen, engineers, technical salesmen. Write. Cleveland Engineering Agency, Cleveland, Ohio.

CIVIL, MECHANICAL, ELECTRICAL, MINING engineers and draftsmen furnished to railroads, irrigation, mining and power companies promptly without charge; securing technical men for western employers nine years. Business Men's Clearing House, Chamber of Commerce Bldg., Denver.

INSTRUCTORS, professors and assistant professors wanted for engineering positions; every spring and summer we are flooded with inquiries from the various technical colleges of America for men experienced as instructors in mechanical, civil, structural, mining, chemical, electrical and hydraulic engineering; we handle engineering exclusively; investigate our methods. The Engineering Agency, Inc. (Est. 1893), Chicago.

AMERICAN SERVICE CO., Pittsburgh, Penn. Require applications for openings; submarine blasting superintendent, channels, $2000-$2400; Leyner drill runners, $175; lighthouse designers-constructors, $4800; hydrographic surveyors of ports-channels, $1800; supervising engineer, breakwater construction, $5000; supervising engineer, terminal railway structures, viaducts and piers, salary negotiable; supervising architect, terminal buildings, Governmental railway commission, S. A., $4000; incidental openings for qualifying assistants on harbor, terminal, improvements, Pacific Coast; Spanish speaking men solicited; thirty-five structural detailers, nine checkers, Middle West, $100 upwards; tracers, $80 upwards; three grain elevator draftsmen, $140; 12 concrete bridge draftsmen, western; others coming. Inquiries invited.

ARCHITECTURAL ENGINEER for American general building contractor operating in Mexico; salary, $150 per month, transportation to the work; position permanent; several railroad map and track draftsmen, salary $75 to $90; six railroad bridge draftsmen, $100-$110; one technically educated man with experience inspecting bridges from the maintenance standpoint, $125; designing engineer, experienced on grain elevators, position in Canada, salary $175; reinforced concrete building contractors' estimator, Ohio, $150. The Engineering Agency, Inc. Twenty years handling technical positions, Monadnock Building, Chicago.

EXPERIENCED RAILROAD foreman wishes position; can also furnish any amount of men; will furnish the best of reference. Box 1040, Eng. News.

WANTED—Instructors and teachers; engineering graduates; lowest commission charges. Cleveland Engineering Agency, Rose Building, Cleveland.

For Sale

FOR SALE—A general civil and mining engineering practice established twenty years; located in a rapidly developing section of West Virginia; consideration $4000, will sell as whole or half interest. Box 885, Eng. News.

VALUABLE PATENT for trench excavating machine for sewers, waterworks, irrigation, drainage, etc.; splendid opportunity for manufacturer or investor. Frederick, 1850 Lincoln Ave., Chicago.

FOR SALE—Stackpole transit in good order; $80. Box 1046, Eng. News.

ENGINEER'S TRANSIT for sale. Call or write 1630 Real Estate Trust Bldg., Philadelphia, Penn.

TREASURY DEPARTMENT, Office of the Supervising Architect, Washington, D. C., June 15, 1912—Sealed proposals will be received at this office until 3 o'clock p. m. on the 24th day of July, 1912, and then opened, for furnishing and installing lighting fixtures in the new United States post office at New York, N. Y., in accordance with drawings and specification, copies of which may be obtained at this office at the discretion of the Supervising Architect. JAMES KNOX TAYLOR, Supervising Architect.

U. S. ENGINEER OFFICE, 540 Federal Building, Buffalo, N. Y., June 1, 1912—Sealed proposals for the construction of concrete superstructure, outer breakwater, Oswego Harbor, N. Y., will be received at this office until 11 A.M. July 1, 1912, and then publicly opened. Information on application. J. G. WARREN, Colonel, Engrs.

Copy for Proposal Advertisements can be accepted until 10 a.m. Wednesday for insertion in the issue of the following Thursday.

COPY for Want Advertisements can be accepted until 10 A. M. Wednesday for insertion in the issue of the following Thursday.

Second Hand Equipment

Rates on Application

FOR SALE

One 1-yd. Lidgerwood Drag Line Excavator, good as new.
Twenty 1½-yd. Open Bottom Steubner Dump Buckets.
Six Hoisting Engines of various sizes.

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For Sale: 2 New Cableways

300′ Span. Cables can be furnished for different span if required. Send for Specifications if interested.

John T. Horton Specialist in Hoisting Machinery

90 West Street, New York City

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All sizes, ⅛ to 24 inches.

Furnished with new threads and couplings, suitable for all practical purposes; large stock constantly on hand, together with a general assortment of used contractors' machinery.

Marine Metal & Supply Co., 167 South Street, New York

LOCOMOTIVES

Four-wheel type; thoroughly overhauled; modern; high working pressure

40 ton 17″ x 24″, with tender. 25 ton 12″ x 18″, saddle tank.
20 ton 11″ x 16″, saddle tank.

SHALL WE SEND DETAILS?

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PIPE, Second-Hand, All Sizes

NEW THREADS AND COUPLINGS

Will sell CHEAP

Pipe & Contractors Supply Co.

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FOR SALE OR RENT

Marion Model 60′ Steam Shovel
Five 9 x 14-36″ Gauge Locomotives
Four 10 x 16-36″ Gauge Locomotives

Jas. S. Braden, 26 Cortlandt St., N. Y.

Second Hand Transits and Levels For Sale

Young & Son Transit (Plain)	$100.00
Wissler Transit (Level)	70.00
Beckman Transit (Reconnoissance)	70.00
Young & Son Level (18″ Telescope)	60.00
Queen Level (16″ Telescope)	60.00
Keuffel & Esser Level (15″ Telescope)	60.00
Keuffel & Esser Level (18″ Telescope)	70.00

SEND FOR COMPLETE LIST

THE ENGINEERING AGENCY, Inc., Monadnock Block, Chicago

FOR SALE

2 No. 5, Style D, Gates Rock Crushers

Are in first-class condition.

THE IOLA PORTLAND CEMENT COMPANY,
IOLA, KANS.

RELAYING RAILS

300 tons 56-lb. Rails with Angles.
300 tons 60-lb. Rails with Angles.
200 tons 74-lb. Rails with Angles.

Other weights. Send me your inquiries.

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RAILS, LOCOMOTIVES

R. R. and Contractors' Equipment, Machinery Piling, Bridges, Tanks, Etc.

IF Buying ZELNICKER (Walter A. Zelnicker Supply Company, St Louis) *IF Selling*

Get our June 64 Page Bulletin, Best Published.

STEAM SHOVELS AND LOCOMOTIVES

Type "O" THEW, high shop number, new style boom, practically new.
VULCAN Giant "D" heavy duty, boom type, 3 sets engines, little used, 1¼ yard dipper.
BALDWIN, 2—9x14″, 36 ga., A-1 condition.
PORTER, 1—9x14″, 36 ga., " "

BARGAINS FOR CASH.

DALLETT & CO., 611-12 Harrison Bldg., Philadelphia

RELAYING RAILS

500 tons 40 lb. rails with angle bars.
500 tons 80 lb. rails, 45 ft. lengths.
1000 tons 90 lb. rails.
Immediate shipment.

Hyde Brothers & Company, Pittsburgh, Pa.

LOCOMOTIVES

Consolidation, Mogul, Ten-Wheel and Switch type; 140 Narrow and Standard Gage.

Largest Stock of Locomotives in United States

Southern Iron and Equipment Co.

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2—Lidgerwood Cableways, 1200 to 1500 feet span.
1—Air Compressor, 225 H. P., Ingersoll-Rand belt driven.
2—Orange Peel Buckets, Hayward 1½ and 1¾ yard capacity.
1—Scraper Car, 36″ gauge, manufactured by Western Wheeled Scraper Co.
1—Economical Boiler, 100 H. P.
6—Stuebner buckets, 60 Cu. Ft., controllable bottom dump.
1—Concrete mixer, ½ yard.
Write for prices and description.

ACME ENGINEERING & CONTRACTING CO.
HERKIMER, N. Y.

ANNOUNCEMENT

The Board of Public Works of the City of Los Angeles, realizing that active construction on the Los Angeles Aqueduct is nearing completion, has authorized the organization of a Sales Department for the purpose of disposing of all excess material and equipment. While large quantities will not be available until the work is over, varying amounts will be released from time to time and either sold at nearest railroad siding or at Receiving Yard, Corner Slauson and Compton avenues.

Material to be sold includes steam and electric power shovels, mules, horses, wagons of all kinds and sizes, electrical equipment, drills, drill steel and sharpeners, compressors, air receivers, pumps, boilers, locomotives, both steam and electric, rail of all sizes, riveted pipe, casing, black pipe, forges, blowers, gas engines, hoists, tunnel and dirt cars, concrete mixers and buggies, lathes, drill presses, steam hammers, machine shop equipment, etc., besides quantities of small tools of every size and description.

Correspondence or personal visits invited regarding any or all items in quantity or otherwise. If articles wanted are not yet available, record will be kept and notification made as soon as same are released.

All communications should be addressed to E. W. Bannister, Sales Engineer, 1108 Central Building.

FOR SALE

Five Bridges, as follows:

Fayette Street Bridge: One 79.2′ span through Pratt truss bridge; 3 trusses spaced 16′ c to c; depth of trusses 12′., 6 panels 13.2′ each long; two roadways each 13′ wide; two footways 7.4′ each wide; two 15″ wrought iron I floorbeams suspended at each panel point.

Gay Street Bridge: One 75′ span, through Pratt truss bridge; 10 panels 7′ 6″ long (each); three trusses 10′ deep at centre and 7′ 6″ deep at ends, spaced 20 ft., c to c; 18″ built floor-beams; beams extend 10′ 7″ beyond outer trusses to support footways; two roadways 15.4′ wide; two footways 7′ 6″ wide each.

Lexington Street Bridge: One 72′ 6″ span deck plate girder bridge; 14 girders, 78′ long, spaced 5′4–13/16″ c to c., curved top flange, 6′ deep at center and 4′6″ at ends; girders connected by X braces at stiffener angles; one roadway 42′ wide, two footways 14′ wide.

These bridges are now in use and will be carefully removed and delivered F.O.B. cars Baltimore. They are in excellent condition. Detailed description and photograph furnished on application.

H. K. McCay, City Engr. Baltimore, Md.

For Sale

PIPE AND CASING AT BARGAIN PRICES

4,000 ft.	—1″	Line Pipe—	1.67 lbs. per ft.
1,600 "	—1¼″	" "	— 3.00 " " "
12,000 "	—2″	" "	— 3.61 " " "
5,900 "	—3″	" "	— 7.50 " " "
2,000 "	—4″	" "	—10.00 " " "
12,000 "	—6¼″	Casing	—13.00 " " "
1,150 "	—8¼″	"	
3,700 "	—8″	Line Pipe	—24.00 " " "

We desire to move our stock of pipe immediately and will quote very low prices for quick sales.
Write or wire us.

G. MATHES IRON & METAL COMPANY

General Offices, 3100-30 North Broadway St. Louis, Mo.

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FOR SALE OR RENT

1—26 Ton, 1¼ Yd. Vulcan traction steam shovel.
1—No. 1, 1 Yd. Thew traction Steam Shovel.
18—S. G. 12 Yd. Western center dump cars.
75—S. G. 5 Yd. one way Allison Dump Cars.
1—12″ Morris Centrifugal belt driven sand Pump.
1—8-wheel S. G. Industrial 10 Ton Locomotive Crane.
1—4-wheel, S. G. Industrial 10 Ton Locomotive Crane.
1—4-wheel S. G. 5 Ton Yale & Towne Locomotive Crane.
1—4-wheel S.G. 2 ton, Brown Locomotive Crane, rigid boom.
1—10 Ton, 3-wheel New York steam road roller.
1—3 Ton tandem Universal puddle roller.
1—2½ Ton Iroquois Asphalt roller.
2—10″x16″ Baldwin, 4 driver, 36″ gauge, S. T. locomotives.
6—10″x16″ Porter, 4 driver, 36″ gauge, S. T. locomotives.
1—13½x22″ Baldwin 6 driver, S.G.S.T. locomotive.
2—Lidgerwood hoisting engines, 14″x18″ D.C. 3 drums.
40—hoisting engines, Mundy, Lidgerwood and Lambert, 10 to 100 H.P.
2—Lambert, 40 and 4–60 H.P. Electric Hoists, D. D. and swinger, D.C. 220 volts.
2—Lambert Cableways, complete, 250′ and 300′.
5—Steel guy derricks, 70′ mast, 65′ boom.
75—Guy and stiff leg derricks (wood), all sizes.
2—2 Yd. Hayward orange peel buckets.
1—2 Yd. Hayward clam shell bucket.
1—1½ Yd. Hayward clam shell bucket.
25—¾ Yd., and 1½ Yd. tipple buckets.

Steam driven Air Compressors, straight line and duplex, from 100 to 2000 cubic feet of air.

Pumps, boilers, engines, drills, crushers, mixers, etc.

HENRY A. HITNER'S SONS CO., Philadelphia, Pa.

FOR SALE

Two Standard Gauge Locomotives.
17—12 yard Oliver Dump Cars.
2 Ingersoll-Rand Class A Air Compressors, 18 x 20½ x 24.
2 Florey Hoisting Engines (7 x 10) complete with reversing boom swinging gear and Drums.

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Electric Hoists

Purchased advantageously—will be sold low.

1—35 H. P. "Mead-Morrison" double drums and swinging gear
1—35 H. P. "American" double drums
2—30 H. P. "Lambert" double drums
1—18 H. P. "Lambert" double drums
1—15 H. P. "Mundy" double drums and swinging gear

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For Sale Or Rent

1500 ft. 24″ gauge 16 lb. portable track.
1200 ft. 24″ gauge 12 lb. portable track, also switches and curves for above track.
13 1 yd. 2 way dump cars.
8 ½ Rotary Dump Cars.
1 No. 2 Ransome Mixer without power.
1 No. 1 Ransome Mixer with gasoline engine.
1 Ransome Mixer with engine and boiler and power loader.
2 ½ yd. Foote Batch Mixers with steam power on trucks with side loader.
1 ½ yd. Foote Batch Mixer with engine and boiler, side loader and builders' hoist.
1 1 yd. Chicago Cube Mixer with engine and superhopper.
2 Guy Derricks, 12x12x55 ft. mast; 10x10x50 ft. Booms with bull wheels.
2 No. 8 Pulsometer Steam Pumps.
2 8″ Centrifugal Pumps with engines direct connected.
1 80 H.P. Ames return tubular portable boiler, stack and fittings.
Complete line of contractors' machinery in stock.

FOOTE-EHRBAR-WILCOX CO.

55 Washington St. New York

Published May, 1912

New McGraw-Hill Books

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Mr. Fuller's big book has had an enthusiastic reception. Probably no branch of engineering has had so important a contribution to its literature. The book is characterized by remarkable fullness of treatment and a sane point of view. It is the result of 25 years of active association with the problems of sewage disposal.

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It gives concrete facts and definite figures. It is not purely theoretical but serves to indicate the lines along which appraisals are made.

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Alphabetical Index to Advertisers

	Page
Abenaque Machine Wks.	28
Abendroth & Root Mfg. Co.	14
Acme Engineering & Contracting Co.	61
Acme Road Mchry. Co.	32
Adams, H. S.	24
Aetna Eng. Burau	25
Ainsworth & Sons, Wm.	23
Albright & Mebus	25
Aldrich Pump Dept.	10
Allen American Manganese Steel Co., Edgar	12
Allen & Garcia A. A. Co.	25
Allentown Testing Lab.	26
Aloe Co., A. S.	23
Alpha Portland Cement Co.	88
Alsen's American Portland Cement Works	88
Alteneder & Sons, Theo.	20
Alvord, John W.	25
Ambursen Hydraulic Construction Co.	92
American Bridge Co.	98
American Bureau Inspection & Tests	26
American Cast Iron Pipe Co.	14
American Clay Mach. Co.	33
American Creosote Works.	87
American District Steam Co.	11
American Drafting Furniture Co.	23
American Engineering Co.	80
American Eng. Corporation	26
American Gas Furnace Co.	12
American Pipe & Construction Co.	14
American Process Co.	88
American Steel & Wire Co.	90
American Well Works	6
Andresen-Evans Co.	82
Andrews, E. J.	25
Architects & Engineers Supply Co.	22
Arend, A. C.	25
Arnold Co.	25
Associated Geological Engineers	24
Atlantic Creosoting and Wood Pres. Co.	87
Atlas Portland Cement Co.	88
Austin Drainage Excavator Co., F. C.	49, 55
Austin-Western Co.	33
Babcock & Wilcox Co.	10
Bacon, Earl C.	33
Baldwin Locomotive Wks., The	31
Balet, Joseph W.	24
Bannister, E. W.	61
Barber Asphalt Pav. Co., Maurer	87
Barbour, F. A.	24
Barker, Roy S.	24
Barrett Mfg. Co.	100
Bartlett & Snow Co., C. O.	51
Beatty & Sons, M.	84
Beaumont Co., R. H.	78
Bergen & Lindeman	10
Berger & Sons, C. L.	22
Berger Mfg. Co.	90
Berlin Constn. Co.	96
Bethlehem Steel Co.	13
Blaisdell Machinery Co.	29
Blake-Knowles Steam Pump Works	11
Blaw Steel Centg. Co.	53
Blickensderfer Mfg. Co.	20
Bogue, Virgil G.	24
Bontecou, Daniel	25
Booth Co., L. M.	11
Booth, Garrett & Blair	26
Boston & Lockport Block Co.	79
Bowman, Austin Lord	24
Braden, James S.	60, 63
Brandis Sons & Co., F. E.	21
Brenneke & Fay	25
Bristol Co., The	34
Brodhead, Alex L.	25
Brown Hoisting Mach. Co.	76
Browning Eng. Co.	81
Buel, A. W.	24
Buff & Buff	29
Buffalo Meter Co.	26
Buffalo Steam Pump Co.	71
Buffalo Steam Roller Co.	55
Buffalo Steel Co.	90
Builders Iron Fdry. Co.	34
Burdick, Chas. B.	25
Burt Mfg. Co.	47
Byers Mach. Co., J. F.	80
Byllesby & Co., H. M.	21
Cable Excavator Co.	84
Cabot, Inc., Samuel	97
Cameron Septic Tank Co.	21
Cameron Steam Pump Wks., A. S.	73
Canton-Hughes Co.	60
Carbolineum Wood Presv. Co.	87
Carlins Sons Co., Thos.	80
Carnegie Steel Co.	94
Carroll-Porter Boiler & Tank Co.	14
Carson Trench Mach. Co.	51
Carter Construction Co.	97
Central Foundry Co.	15
Chase, Chas. P.	21
Chester & Fleming	25
Chicago Concrete Machinery Co.	69
Chicago Pneumatic Tool Co.	28
Chicago Steel Tape Co.	22
City Wastes Disposal Co.	24
Clarkson School of Tech.	27
Cleveland City Forge and Iron Co.	81
Clinton Wire Cloth Co.	33, 99
Clow & Sons, J. B.	14
Clyde Iron Works	77
Coffin Valve Co.	19
Coldwell-Wilcox Co.	19
Cole, John A. & Edw. S.	24
Collins, Charles E.	25
Columbia Wagon Co.	32
Concrete Steel Co.	91
Conklin Engineering Co.	25
Continental Car & Equipment Co.	31
Contractors Plant Mfg. Co.	76
Cook Well Co.	19
Coplay Portland Cement Co.	88
Cornell University	26
Croton Falls Construction Co.	63
Cyclone Drill Co.	28
Dabney Engineering Co.	26
Dallett & Co.	60
Davenport Locomotive Works	30
Day & Zimmermann	25
Deming Co.	6
Des Moines Bridge & Iron Co.	15
Detroit Leather Specialty Co.	4
Detroit Steel Products Co.	3
Directory of Consulting Engineers	24, 25, 26
Dixon Crucible Co., Jos.	15
Dobbie Fdry. & Mach. Co.	76
Dodge Co., J. M.	78
Donaldson Iron Co.	14
Dover Boiler Works	15
Dow & Smith	24
Drum & Co., A. L.	25
Drummond & Co., M. J.	14
Duff, Samuel E.	25
Eagle Wagon Works	33
East Jersey Pipe Co.	19
Eastern Bridge & Structural Co.	97
Eastern Mfg. Co.	18
Edson Mfg. Co.	7
Elliott Co., B. K.	22
Engineering Agency	60
Exeter Machine Works	81
Federal Engineering Co.	25
Flory Mfg. Co., S.	77
Foote Concrete Mach. Co.	71
Foote-Ehrbar-Wilcox Co.	61
Forbes Co.	97
Fort Pitt Bridge Wks.	96
Fort Wayne Electric Wks.	29
Fowler, Chas. E.	26
Fox & Co., John	14
Franklin Steel Co.	92
French Co., Samuel H.	88
Fuertes, James H.	24
Fuller, George W.	24
Gamon Meter Co.	19
Gandy Belting Co.	79
General Concrete Construction Co.	11
General Fire Extinguisher Co.	7
General Fireproofing Co.	4
Githens, Geo. S.	63
Glamorgan Pipe & Foundry Co.	14
Goubert, A. A.	87
Gray, Samuel M.	24
Green Fuel Economizer Co.	11
Guarantee Construction Co.	78
Gulick, Henderson & Co.	26
Gurley, W. & L. E.	22
Haiss Mfg. Co., Geo.	81
Hanna Mfg. Co.	22
Harrison Safety Boiler Works	10
Hartford Paving & Construction Co.	53
Hartranft Cement Co., Wm. G.	88
Hastings, F. A.	25
Hatton, T. Chalkley	26
Hayward Co., The	82
Hazard Mfg. Co.	81
Hazelhurst, James Nisbet	26
Hedrick & Cochrane	26
Heine Safety Boiler Co.	10
Heller & Brightly	22
Hering & Gregory	24
Herington, G. B.	26
Hervey, C. L.	26
Hess Flume Co.	15
Hildreth & Co.	26
Hill, Jr., Nicholas S.	24
Hinchman, Jr., T. H.	26
Hitner & Sons, Henry A.	61
Hooker Electrochemical Co.	51
Hopkins, Chas. C.	24
Horton, John T.	60
Hotchkiss Lock Metal Form Co.	94
Hunt Co., R. W.	26
Hyde Bros. Co.	60
Hydrex Felt & Engineering Co.	3
Indianapolis Switch & Frog Co.	30
Industrial Supply & Equipment Co.	83
Industrial Works	81
Ingersoll-Rand Co.	29
Insley Mfg. Co.	69
International Clay Products Bureau	19
International Creosoting & Construction Co.	87
Iola Portland Cement Co.	60
Janney-Steinmetz Co.	86
Jeanesville Iron Works Co.	8
Jeffrey Mfg. Co.	79
Johnson & Fuller	24
Johns-Manville Co., H. W.	7
Johnston, Robt.	22
Jones & Laughlin Steel Co.	71
Jones & Co., Morgan T.	26
Keith, Herbert C.	24
Kellogg, M. W.	10
Kennedy, Julian	25
Kent, R. S.	24
Kenwood Bridge Co.	96
Keuffel & Esser Co.	21
Keystone Driller & Pump Co.	7
Keystone Driller Shops	29
Keystone National Powder Co.	86
Kinnear Mfg. Co.	73
Knowles, Morris	25
Koehring Machine Co.	69
Kolesch & Co.	21
Lackawanna Bridge Co.	95
Lackawanna Steel Co.	2
Ladd & Baker, Inc.	25
Laidlaw-Dunn-Gordon Co.	29
Landreth, Olin H.	24
Lansing Co.	71
Lawrence Cement Co.	89
Lawrence Machine Co.	6
Leadite Co.	14
Lederle & Provost	24
Leffel & Co., James	8
Lehigh Portland Cement Co.	87
Lehigh Valley Testing Laboratories	26
Leopold & Co., J.	51
Lewis Institute	27
Lidgerwood Mfg. Co.	77
Lietz Co., A.	22
Light, Heat & Power Corp.	24
Link-Belt Co.	81
Longenecker & Co., C.	83, 85
Lucius, Albert	24
Ludlow Valve Mfg. Co.	8
Lufkin Rule Co.	22
Luten, Daniel B.	26
MacArthur Concrete Pile & Foundation Co.	94
Main, Chas. T.	24
Manhattan Drilling Co.	29
Marine Metal & Supply Co.	60
Marion Malleable Iron Wks.	16
Marsh Capron Mfg. Co.	71
Mason, W. P.	24
Massillon Bridge & Structural Co.	96
Mathes Iron & Metal Co.	61
Maury, Dabney H.	26
McAlbee Powder & Oil Co., G. R.	61
McClintic-Marshall Cons. Co.	98
McConway & Torley Co.	30
McCulloh, W.	24
McGowan Co., John H.	6
McGraw-Hill Book Co.	62
McKiernan-Terry Drill Co.	28
McMyler Interstate Co.	81
McWane Pipe Works	14
Mead-Morrison Mfg. Co.	82
Merrill Bros.	80
Metaline Co., The	33
Metcalf & Eddy	26
Michigan Pipe Co.	16
Mietz, August	12
Millar & Sons Co., Chas.	13
Miller, Hiram Allen	24
Milwaukee Bridge Co.	96
Minneapolis Steel & Machinery Co.	97
Missouri Valley Bridge & Iron Co.	97
Modjeski & Angier	26
Monighan Machine Co.	84
Montana State School of Mines	27
Moran, Daniel E.	24
Morgan Eng. Co.	26
Morris Machine Works	6
Morse Chain Co.	80
Mount Vernon Bridge Co.	96
Mundy, J. S.	77
Municipal Engineering & Contracting Co.	65
National Corrugated Culvert Co.	17
National Fireproofing Co.	93
National Hoisting Eng. Co.	80
National Meter Co.	20
National Tube Co.	18
Neptune Meter Co.	1
Neuchatel Asphalt Co.	29
New, H. S.	25
Newcomb, John Lloyd	26
N. Y. Continental Jewell Filt. Co.	51
Norbom Engineering Co.	84
Norfolk Creosoting Co.	87
North American Metaline Co.	33
Northfield Iron Co.	71
Norwalk Iron Works	29
Ohio Locomotive Crane Co.	79
Ohio Northern University	27
Oliver Mfg. Co., W. J.	30
Orenstein-Arthur Koppel Co.	31
Oshkosh Mfg. Co.	8
Otto Gas Engine Works	12
Pacific Flush Tank Co.	57
Pacific Tank & Pipe Co.	16
Parker, A. A.	8
Parsons Co., G. W.	51
Patterson Co., W. W.	96
Pease Co., C. F.	22
Penn Bridge Co.	97
Pennsylvania Cement Co.	88
Pennsylvania Military College	27
Pennsylvania R.R.	15
Pennsylvania Steel Co.	98
Petroleum Iron Works	12
Phoenix Bridge Co.	96
Pipe & Contractors Supply Co.	60
Pitometer Co.	34
Pittsburgh Block & Mfg. Co.	96
Pittsburgh Meter Co.	19
Pittsburgh Testing Laboratory	26
Porter Co., H. K.	31
Portland Wood Pipe Co.	16
Potter, Alexander	25
Potts, Clyde	25
Power Specialty Co.	12
Prescott Steam Pump Co., Fred M.	4
Proctor, Olin S.	25
Proposals	48, 50, 52
Pulsometer Steam Pump Co.	4
Rail Joint Co.	30
Ramapo Iron Works	31
Randolph, Isham	26
Ransome Concrete Machinery Co.	67
Ransome Engineering Co.	25
Raymond Concrete Pile Co.	95
Redwood Manufacturers Co.	18
Rensselaer Polytechnic Institute	27
Riter-Conley Mfg. Co.	98
Riverside Bridge Co.	6
Roberts Filter Mfg. Co.	19
Robins Conveying Belt Co.	78
Robinson, A. W.	26
Robinson & Wagner	25
Rockport Granite Co.	92
Roebling Construction Co.	51
Rose Polytechnic Institute	27
Safety Car Heating & Lighting Co.	31
Sanderson & Porter	26
Sandusky Portland Cement Co.	89
Scherzer Rolling Lift Bridge Co.	96
Schieren Co., Chas. A.	77
Schreiber Sons Co., L.	96
Scofield Engineering Co.	25
Schools & Colleges	27

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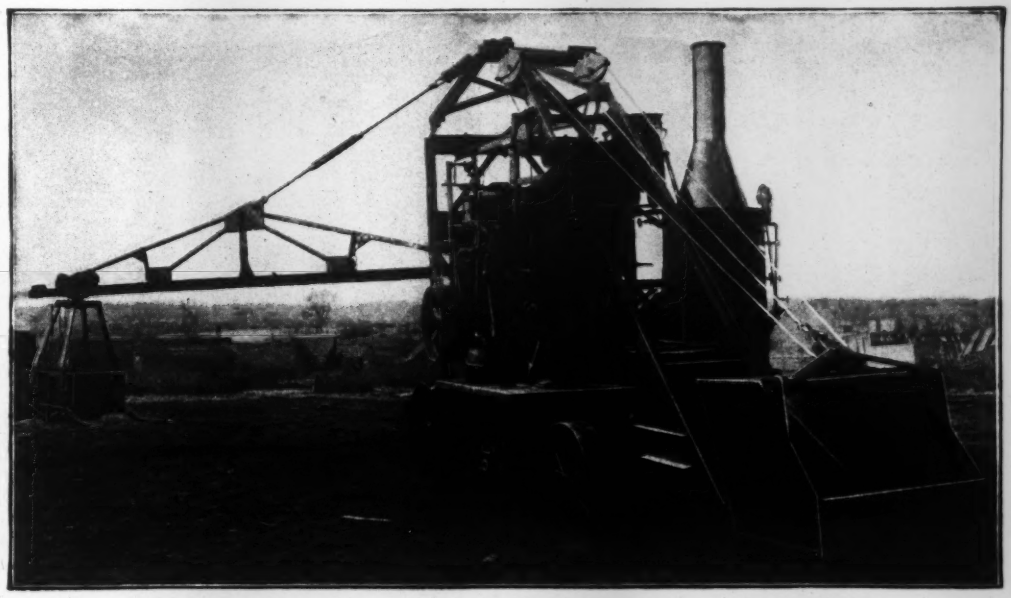

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AGENTS WANTED IN OPEN TERRITORY

	Page
Second-hand Material, 60, 61,	63
Sessions Foundry Co.	18
Seyfert's Sons, L. F.	61
Sheffield School of Yale	27
Sherwood, E. C.	60
Shoemaker & Co., Lewis F.	96
Sicilian Asphalt Paving Co.	30
Simmons Co., John	18
Simplex Valve & Meter Co.	18
Situations Wanted 58,	59
Smidth & Co., F. L.	89
Smith Co., S. Morgan	8
Smith Co., T. L.	75
Smith & Sons, Theo.	85
Smooth-On Mfg. Co.	7
Solomon-Norcross Co.	26
Soltmann, E. G.	22
Southern Iron & Equipment Co.	60
Spackman Engineering Co.	27
Standard Asphalt & Rubber Co.	29
Standard Pipe Jack Co.	57
Standard Water Meter Co.	20
Steel Protected Concrete Co.	95
Stone & Webster Eng. Corporation	24
Streeter Clip & Specialty Co.	95
Streicher Co., H. P.	63
Strobel Steel Cons. Co.	96
Studebaker Corporation, The	33
Sullivan Machinery Co.	28
Swenson, Emil	25
Tacoma Wood Pipe Co.	16
Talley's Sons, Thomas J.	86
Taylor Iron & Steel Co.	12
Terry & Trench, Inc.	79
Testing Laboratories 26,	27
Thew Automatic Shovel Co.	85
Tighe, James L.	24
Tippett & Wood	12
Trenton Iron Co.	82
Tribus & Massa	25
Trojan Powder Co.	86
Troy Wagon Works	32
Truesdell, Walter E.	25
Trussed Concrete Steel Co.	5
Tufts College	27
Turner, C. A. P.	26
Turner Construction Co.	89
Turner & Moore	26
Underground Const. Co.	95
Underwriters' Laboratory	27
Union Iron Works	84
Universal Drafting Mach. Co.	23
Universal Portland Cement Co.	88
University of Illinois	27
University of Vermont	27
U. S. Cast Iron Pipe & Foundry Co.	14
U. S. Wind Engine & Pump Co.	18
Virginia Bridge & Iron Co.	97
Vrooman, Morrell	25
Vulcan Iron Wks. (Chicago)	82
Vulcan Iron Wks. (Wilkes-Barre) 31,	89
Vulcanite Portland Cement Co.	89
Waclark Titanite Explosive Co.	86
Waddell & Harrington	26
Wadsworth, Howland & Co.	89
Waldron, Frederic A.	25
Want & For Sale Ads 58,	59
Warren Bros. Co.	30
Waring, Chapman & Farquhar	25
Washington Pipe & Fdry. Co.	16
Watkins, Thomas	19
Watson Wagon Co.	53
Weber & Co., F.	21
Weber Chimney Co.	10
Wemlinger Steel Piling Co.	94
Westinghouse Air Brake Co.	9
Westinghouse Elec. & Mfg. Co.	9
Weston, E. B.	24
Weston, Robert Spurr	24
White Co., J. G.	25
Whitehall Cement Mfg. Co.	88
Whitney, O. R.	60
Wiener Co., Ernst	30
Wiener Machinery Co.	33
Wiley & Sons, John	34
Wilkins Co., W. G.	25
Williams, Brown & Earle	22
Williams Co., G. H.	85
Williams, G. S.	26
Wilson Co., E. H.	60
Wood, H. S.	25
Wood & Co., R. D.	14
Worden-Allen Co.	95
Wyckoff Pipe & Creosote Co.	87
Wyckoff & Son Co., A. 11,	18
Yereance, W. B.	25
Young, C. G.	25
Young & Hyde	25
Youngstown Iron & Steel Co.	96
Zelnicker, W. A.	60

Classified Index to Articles Advertised

Asphalt

Hydrex Felt & Engineering Co.	3
Neuchatel Asphalt Co.	29
Sicilian Asphalt Paving Co.	30
Standard Asphalt & Rubber Co.	29

Asphalt Liquid

Neuchatel Asphalt Co.	29
Standard Asphalt & Rubber Co.	29

Barges (Steel)

Des Moines Bridge & Iron Co.	15

Bearings and Bushings

Metaline Co.	33

Belt Dressing

Dixon Crucible Co., Jos.	15
Gandy Belting Co.	79

Belting

Gandy Belting Co.	79
Robins Conveying Belt Co.	78
Schieren & Co., Chas. A.	77

Benders, Bar

Ransome Concrete Machinery Co.	67
Wiener Machinery Co.	33

Bins, Storage

Beaumont Co., R. H.	78
Brown Hoisting Mchry. Co.	76
Ransome Concrete Machinery Co.	67
Raymond Concrete Pile Co.	95

Blasting Supplies

Keystone National Powder Co.	86
Trojan Powder Co.	86
Waclark Titanite Explosive Co.	86

Blocks

Boston & Lockport Block Co.	79
Bobbie Fdry. & Mach. Co.	76
Contractors' Plant Mfg. Co.	76
Haiss Mfg. Co., Geo.	81
National Hoisting Engine Co.	80
Patterson Co., W. W.	96
Pittsburg Block & Mfg. Co.	96

Blowers

Green Fuel Economizer Co.	11

Blow-pipes and Burners

American Gas Furnace Co.	12

Blowers, Pressure

American Gas Furnace Co.	12

Blue Prints

Keuffel & Esser Co.	21
Pease & Co., C. F.	22
Soltmann, E. G.	22

Blueprinting Machines

Keuffel & Esser Co.	21
Pease Co., C. F.	22
Williams, Brown & Earle,	22

Boilers

Babcock & Wilcox Co.	10
Carroll-Porter B. & T. Co.	14
Heine Safety Boiler Co.	10
Lidgerwood Mfg. Co.	77
Petroleum Iron Works Co.	12

Books

McGraw-Hill Book Co.	62
Wiley & Sons, John	34

Bolts

American Steel & Wire Co.	90
Pennsylvania Steel Co.	98

Brakes, Air

Westinghouse Air Brake Co.	9

Brick-making Machinery

American Clay Mchry. Co.	33

Bridges and Buildings

American Bridge Co.	98
Berlin Construction Co.	96
Eastern Bridge & Structural Co.	97
Fort Pitt Bridge Works	96
Kenwood Bridge Co.	96
Lackawanna Bridge Co.	95
Lackawanna Steel Co.	2
Massillon Bridge & Structural Co.	96
McClintic Marshall Construction Co.	98
McMyler Interstate Co.	81
Milwaukee Bridge Co.	96
Minneapolis Steel & Machinery Co.	97
Missouri Valley Bridge & Iron Co.	97
Mt. Vernon Bridge Co.	96
National Fireproofing Co.	93
Penn Bridge Co.	97
Pennsylvania Steel Co.	98
Phoenix Bridge Co.	96
Riter-Conley Mfg. Co.	98
Riverside Bridge Co.	96
Scherzer Rolling Lift Bridge Co.	96
Schreiber & Sons, L.	96
Shoemaker & Co., Lewis F.	96
Strobel Steel Construction Co.	96
Virginia Bridge & Iron Co.	97
Worden-Allen Co.	95

Buckets, Concrete

Haiss Mfg. Co., Geo.	81
Hayward Co.	82
Insley Mfg. Co.	69
McMyler Interstate Co.	81
Ransome Concrete Machinery Co.	67
Union Iron Works	84

Buckets, Drag-Line Scraper

Hayward Co.	82
Monighan Machine Co.	84

Buckets, Dredging

Andresen-Evans Co.	82
Haiss Mfg. Co., Geo.	81
Hayward Co.	82
Industrial Supply & Equipment Co.	83
Industrial Works.	81
McMyler Interstate Co.	81
Mead Morrison Mfg. Co.	82
Smith & Sons, Theo.	85
Williams Co., G. H.	85

Buckets, Grab

Andresen-Evans Co.	82
Beatty & Sons, M.	84
Brown Hoisting Mchry. Co.	76
Williams Co., G. H.	85

Buckets, Orange Peel and Clam Shell

Browning Engineering Co.	81
Exeter Machine Works	81
Haiss Mfg. Co., Geo.	81
Hayward Co.	82
Industrial Supply & Equipment Co.	83
Industrial Works.	81
Jeffrey Mfg. Co.	79
McMyler Interstate Co.	81
Mead-Morrison Mfg. Co.	82
Smith & Sons, Theo.	85
Union Iron Works.	84

Building Paper

Barrett Mfg. Co.	100
Cabot, Inc., Samuel	97
Hydrex Felt & Engineering	3

Building Specialties

Streeter Clip & Specialty Co.	95

Cableways

Brown Hoisting Mchry. Co.	76
Cable Excavator Co.	84
Carson Trench Machine Co.	51
Flory Mfg. Co. S.	77
Lidgerwood Mfg. Co.	77
Longenecker & Co., C.	83, 85
Trenton Iron Co.	82

Caissons

Petroleum Co.	12

Car Heaters

Safety Car Heating & Lighting Co.	31

Car-Lighting Systems

Safety Car Heating & Lighting Co.	31

Cars, Contractors

Continental Car & Equipment Co., Inc.	31
Union Iron Works.	84

Cars, Dump

Continental Car & Equipment Co., Inc.	31
Oliver Mfg. Co., Wm. J.	30
Orenstein-Arthur Koppel Co.	31
Wiener Co., Ernst	30

Cars, Flat

Continental Car & Equipment Co., Inc.	31

Cars, Industrial

Chicago Concrete Machinery Co.	69
Continental Car & Equipment Co., Inc.	31
Orenstein-Arthur Koppel Co.	31
Ramapo Iron Works.	31
Smith Co., T. L.	75
Wiener Co., Ernst	30

Cars, Spreader

Continental Car & Equipment Co., Inc.	31
Orenstein-Arthur Koppel Co.	31

Cars, Tank

Petroleum Iron Works Co.	12

Car Dumpers

Brown Hoisting Mchry. Co.	76
McMyler Interstate Co.	81
Sullivan Machinery Co.	28

Carts, Concrete

Chicago Concrete Machinery Co.	69
Ransome Concrete Machinery Co.	67
Smith Co., T. L.	75

Carts, Dump

Studebaker Corporation, The	33
Watson Wagon Co.	53

Castings, Iron and Steel

American Cast Iron Pipe Co.	14
Central Foundry Co.	15
Donaldson Iron Co.	14
Fox Co., John	14
Kellogg Co., M. W.	10
Lackawanna Steel Co.	2
Marion Malleable Iron Works	16
McConway & Torley Co.	30
McWane Pipe Works.	14
Parsons Co., G. W.	51
Robins Conveying Belt Co.	78
Sessions Foundry Co.	18
United States Cast Iron Pipe & Foundry Co.	14

Castings, Malleable Iron

Marion Malleable Iron Wks.	16

Castings, Manganese Steel

Allen American Manganese Steel Co., Edgar	12
Indianapolis Switch & Frog Co.	30
Taylor Iron & Steel Co.	12

Cement-making Machinery

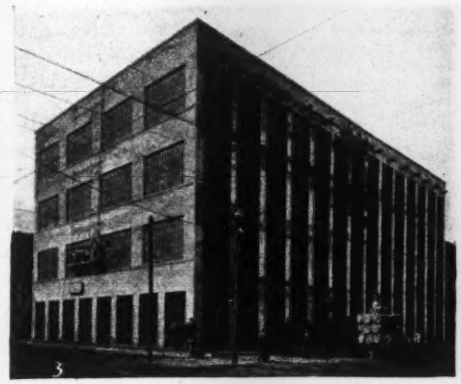
American Process Co.	88
Smidth & Co., F. L.	89

Cement for Iron

Smooth-On Mfg. Co.	7

Cement, Natural

Alsen's American Portland Cement Works.	88
Atlas Portland Cement Co.	88



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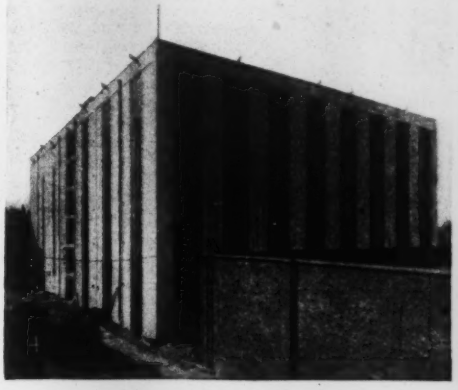

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31-105

FOREIGN AGENTS—Buenos Aires: Venge y Cia, Corrientes 441. Copenhagen: Isidor Heimann & Co. Milan: E. Parodi Delfino.

Cement, Portland
Alpha Portland Cement Co. 88
Alsen's American Portland Cement Works 88
Atlas Portland Cement Co. 88
Coplay Cement Mfg. Co. 88
French & Co., S. H. 88
Hartranft Cement Co., W. G. 88
Lawrence Cement Co. 89
Lehigh Portland Cement Co. 87
Pennsylvania Cement Co. 88
Sandusky Portland Cement Co. 89
Universal Portland Cement Co. 88
Vulcanite Portland Cement Co. 89
Whitehall Cement Mfg. Co. 88

Cement, Portland, White
Atlas Portland Cement Co. 88
French & Co., S. H. 88
Sandusky Portland Cement Co. 89
Vulcanite Portland Cement Co. 89

Cement, Roofing
Neuchatel Asphalt Co. 29
Sandusky Portland Cement Co. 89

Centers, Steel Collapsible
Blaw Steel Centering Co. 53
Hartford Paving & Construction Co. 53

Centers, Wood Collapsible
Hartford Paving & Construction Co. 53

Chain
Pittsburg Block & Mfg. Co. 96

Chains, Transmission
Link-Belt Co. 81
Morse Chain Co. 80
Taylor Iron & Steel Co. 12

Channeling Machines
Ingersoll-Rand Co. 29
Sullivan Machinery Co. 28

Chloride of Lime
Hooker Electrochemical Co. 51

Chimneys, Concrete
General Concrete Construction Co. 11
Kellogg Co., M. W. 10
Weber Chimney Co. 10

Chimneys, Radial Brick
Bergen & Lindeman 10
Kellogg Co., M. W. 10

Clips, Steel
Streeter Clip & Specialty Co. 95

Cloth, Tracing
Pease & Co., C. F. 22
Soltmann, E. G. 22

Coal and Ore-handling Machinery
Beaumont Co., R. H. 78
Brown Hoisting Machry. Co. 76
Dodge Co., J. M. 78
Guarantee Construction Co. 78
Haiss Mfg. Co., Geo. 81
Hayward Co. 82
Jeffrey Mfg. Co. 79
Link-Belt Co. 81
McMyler Interstate Co. 81
Mead-Morrison Co. 82

Coal-storage Systems
Brown Hoisting Mchry. Co. 76
Dodge Co., J. M. 78
Guarantee Construction Co. 78
Link-Belt Co. 81
Mead-Morrison Mfg. Co. 82

Compounds, Cement Waterproofing
Cabot, Inc., Samuel 97
Smooth-On Mfg. Co. 7
Trussed Concrete Steel Co. 5

Compressors, Air
Abenaque Machine Wks. 28
American Well Works 6
Blaisdell Mchy. Co. 29
Chicago Pneumatic Tool Co. 28
Deming Co. 6
Ingersoll-Rand Co. 29
Laidlaw-Dunn-Gordon Co. 29
McKiernan-Terry Drill Co. 28
Mietz, August 12
Norwalk Iron Works 29
Otto Gas Engine Works 12
Sullivan Machinery Co. 28
Westinghouse Air Brake Co. 9

Compressors, Gas and Ammonia
Blaisdell Machry. Co. 29
Laidlaw-Dunn-Gordon Co. 29
Norwalk Iron Works 29

Concrete Finishing Tools
Ransome Concrete Machinery Co. 67

Concrete Floor Coatings
Trussed Concrete Steel Co 5

Concrete Reinforcement
American Steel & Wire Co. 90
Brown Hoisting Machry. Co. 76
Buffalo Steel Co. 90
Clinton Wire Cloth Co. 33, 99
Concrete Steel Co. 91
Franklin Steel Co. 92
General Fireproofing Co. 4
Jones & Laughlin Steel Co. 71
Steel Protected Concrete Co. 95
Trussed Concrete Steel Co., 5

Concrete Construction
Berger Mfg. Co. 90
Brown Hoisting Mchry. Co. 76
Concrete Steel Co. 91
Raymond Concrete Pile Co. 95
Roebling Construction Co. 51
Trussed Concrete Steel Co., 5

Condensers
Cameron Steam Pump Works, A. S. 73
Jeanesville Iron Works Co. 8
Kellogg Co., M. W. 10

Conduit
Johns-Manville Co., H. W. 7

Contractors, General
Carter Construction Co. 97
Dodge Co., J. M. 78

Conveyors
Beaumont Co., R. H. 78
Dodge Co., J. M. 78
Jeffrey Mfg. Co. 79
Link-Belt Co. 81
Ohio Locomotive Crane Co. 79
Robins Conveying Belt Co. 78

Corner Bar Curb Reinforcing
Steel Protected Concrete Co. 95

Couplers, Car
McConway & Torley Co. 30

Cranes, Locomotive
Brown Hoisting Mchry. Co. 76
Browning Engineering Co. 81
Dodge Co., J. M. 78
Exeter Machine Works 81
Industrial Works 81
Link-Belt Co. 81
McMyler Interstate Co. 81
Ohio Locomotive Crane Co. 79

Cranes, Traveling
Brown Hoisting Mchry. Co. 76

Cranes, Wrecking
Brown Hoisting Mchry. Co. 76
Exeter Machine Works 81
Industrial Works 81
McMyler Interstate Co. 81
Ohio Locomotive Crane Co. 79

Crayons, Marking
Dixon Crucible Co., Jos. 15

Creosoting
American Creosote Works. 87
Atlantic Creosoting & Wood Preserving Works. 87
Barber Asphalt Paving Co. (Maurer) 87
Carbolineum Wood Preserving Co. 87
International Creosoting & Construction Co. 87
Norfolk Creosoting Co. 87
Wyckoff Pipe & Creosoting Co. 87

Crucibles
Dixon Crucible Co., Jos. 15

Crushers and Pulverisers
Acme Road Machinery Co. 32
Austin-Western Co. 33
Bacon, Earle C. 33
Chicago Concrete Machinery Co. 69
Jeffrey Mfg. Co. 79
Longenecker & Co., C. 83, 85
Robins Conveying Belt Co. 78
Smidth & Co., F. L. 89
Smith Co., T. L. 75

Culverts, Corrugated Metal
Hess Flume Co. 15
National Corrugated Culvert Co. 17

Curb and Curb and Gutter Forms
Blaw Steel Centering Co. 53
Hotchkiss Lock Metal Form Co. 94

Curb, Steel Protected Concrete
Steel Protected Concrete Co. 95

Cutters, Bar
Wiener Machinery Co. 33

Dams
Ambursen Hydraulic Construction Co. 92

Derricks
Contractors Plant Mfg. Co. 76
Dobbie Fdry. & Mach. Co. 76
Flory Mfg. Co., S. 77
Hayward Co. 82
Lidgerwood Mfg. Co. 77
Longenecker & Co., C. 83, 85
McMyler Interstate Co. 81
National Hoisting Engine Co. 80
Terry & Tench Co. 79

Derrick Irons
Byers Mach. Co., John F. 80
Dobbie Fdry. & Mach. Co. 76
Hayward Co. 82
Monighan Machine Co. 84
Mundy, J. S. 77
Terry & Tench Co. 79
Union Iron Works 84

Ditching Machinery
Austin Drainage Excavator Co., F. C. 49, 55

Doors, Steel and Wood Rolling
Kinnear Mfg. Co. 73

Drafting Machines
Universal Drafting Machine Co. 23

Drawing Materials
Architects & Engineers Supply Co. 22
Keuffel & Esser Co. 21
Kolesch & Co. 21
Soltmann, E. G. 22
Weber & Co., F. 21

Dredges
Beatty & Sons, M. 84
Hayward Co. 82
Longenecker & Co., C. 83, 85
Norbom Engr. Co. 84
Smith & Sons, Theo. 85

Drills, Core
Cyclone Drill Co. 28
Ingersoll-Rand Co. 29
Keystone Driller Shops 29
Manhattan Drilling Co. 29
McKiernan-Terry Drill Co. 28
Sullivan Machinery Co. 28

Drills, Electric
Fort Wayne Electric Wks. 29

Drills, Hammer
Ingersoll-Rand Co. 29
McKiernan-Terry Drill Co. 28
Sullivan Machinery Co. 28

Drills, Pneumatic
Chicago Pneumatic Tool Co. 28
Ingersoll-Rand Co. 29
Sullivan Machinery Co. 28

Dryers
American Process Co. 88
Bartlett & Snow Co., C. O. 51

Dump Boxes
Studebaker Corporation, The 33

Dynamite
Keystone National Powder Co. 86
Trojan Powder Co. 86
Waclark Titanite Explosive Co. 86

Economizers
Green Fuel Economizer Co. 11

Elevators, Bucket
Acme Road Mchry. Co. 32
Beaumont Co., R. H. 78
Chicago Concrete Machinery Co. 69
Jeffrey Mfg. Co. 79
Link-Belt Co. 81
Robins Conveying Belt Co. 78
Smith Co., T. L. 75

Elevators, Concrete
Chicago Concrete Machinery Co. 69
Insley Mfg. Co. 69
Koehring Machine Co. 69
Ransome Concrete Machinery Co. 67
Smith Co., T. L. 75

Engineers, Consulting
See pages 24, 25, 26

Engines, Gas and Gasoline
Abenaque Machine Works. 28
Bethlehem Steel Co. 13
Mietz, August 12
National Meter Co. 20
Otto Gas Engine Works. 12

Engines, Hoisting
American Engineering Co. 80
Beatty & Sons, M. 84
Brown Hoisting Mchry. Co. 76
Byers Machine Co., John F. 80
Carlin's Sons, Thos. 80
Clyde Iron Works. 77
Contractors Plant Mfg. Co. 76
Dobbie Foundry & Machine Co. 76
Exeter Machine Works. 81
Flory Mfg. Co., S. 77
Koehring Machine Co. 69
Longenecker & Co., C. 83, 85
Mead Morrison Mfg. Co. 82
Monighan Machine Co. 84
Mundy, J. S. 77
National Hoisting Engine Co. 80
Otto Gas Engine Works. 12

Engines, Oil
Mietz, August 12
Otto Gas Engine Works. 12

Engines, Pumping
Abenaque Machine Works. 28
Aldrich Pump Department. 10
Bethlehem Steel Co. 13
Laidlaw-Dunn-Gordon Co. 29
Otto Gas Engine Works. 12
Prescott Steam Pump Co., F. M. 4

Engines, Steam
Blake & Knowles Steam Pump Works. 11
Lawrence Machine Co. 68

Engines, Traction
Abenaque Machine Works. 28
Buffalo Steam Roller Co. 32

Excavating Attachment, Derrick
Union Iron Works. 84

Excavators, Cable
Cable Excavator Co. 84

Excavators, Drag Line
Hayward Co. 82
Lidgerwood Mfg. Co. 77
McMyler-Interstate Co. 81
Monighan Machine Co. 84
Parsons Co., G. W. 51

Exhaust Heads
Burt Mfg. Co. 47

Expanded Metal
General Fireproofing Co. 4
Roebling Construction Co. 51
Trussed Concrete Steel Co., 5

Facings, Foundry
Dixon Crucible Co., Joseph 15
Westinghouse Electric Mfg. Co. 9

Fencing, Wire
Clinton Wire Cloth Co. 33, 99

Filters, Oil
Burt Mfg. Co. 47

Filters, Water
New York Cont'l Jewell Filtration Co. 51
Pacific Tank & Pipe Co. 16
Roberts Filter Mfg. Co. 19
Simplex Valve & Meter Co. 18

Fire Extinguishing Apparatus
General Fire Extinguisher Co. 7

Flooring
Hydrex Felt & Engineering Co. 3
Youngstown Iron & Steel Co. 96

Flumes, Metal
Hess Flume Co. 15

Flushers (Street)
Studebaker Corporation, The 33

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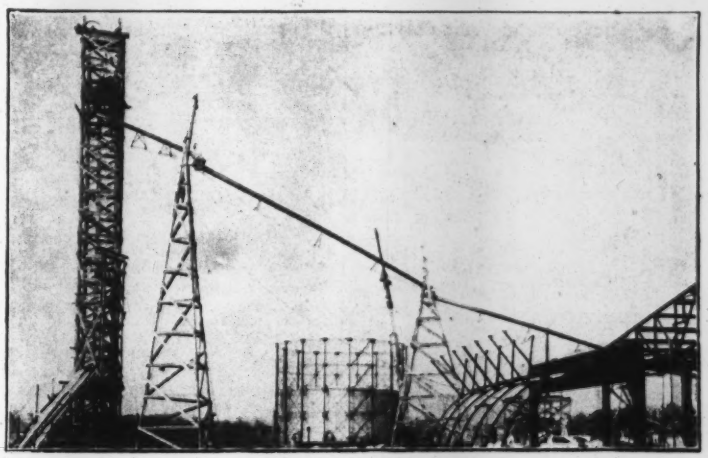

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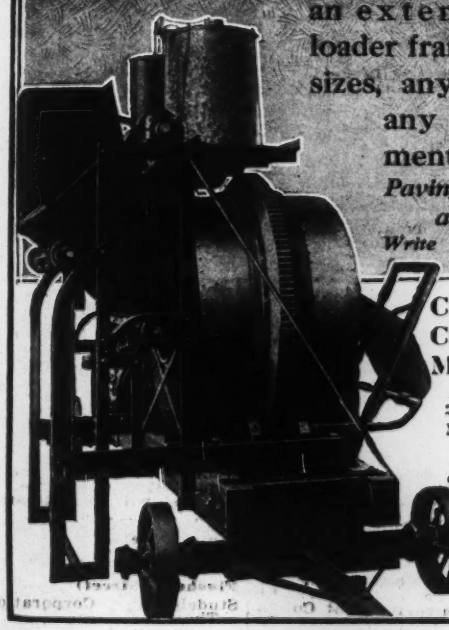

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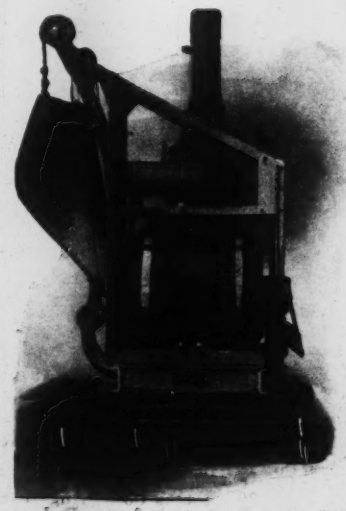

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Koehring Machine Co., Milwaukee, Wis.

Forms, Metal for Concrete
Blaw Steel Centering Co... 53
Hartford Paving & Construction Co... 53
Hotchkiss Lock Metal Form Co... 94
Ransome Concrete Machinery Co... 67

Forms, Wood for Concrete
Hartford Paving & Construction Co... 53

Foundations
Raymond Concrete Pile Co. 95
Underground Construction Co. ... 95

Frogs and Switches
Indianapolis Switch & Frog Co. ... 30
Orenstein-Arthur Koppel Co. ... 31
Ramapo Iron Works... 31
Wiener Co., Ernst... 30

Furnaces, Annealing and Tempering
American Gas Furnace Co. 12

Furnaces, Gas
American Gas Furnace Co. 12

Furniture and Supplies Drafting Room
Aloe Co., A. S... 23
American Drafting Furniture Co... 23

Gages, Recording
Bristol Co... 34

Garbage Disposal Apparatus
Bartlett & Snow Co., C. O.. 51

Gaskets, Leather
Detroit Leather Specialty Co. ... 4

Gas Producer Plants
Otto Gas Engine Works... 12

Generators, Electric
Fort Wayne Electric Wks. 29
Westinghouse Electric & Mfg. Co... 9

Governors, Water Wheel
Ludlow Valve Mfg. Co.... 8

Graders
Austin-Western Co... 33
Buffalo Steam Roller Co... 32

Granite
Leopold & Co., J... 51
Rockport Granite Co... 92

Graphite
Dixon Crucible Co., Jos.... 15

Hammers, Drop
Merrill Bros... 80

Hammers, Steam
Goubert, A. A... 87
Union Iron Works... 84

Headgates
Hess Flume Co... 15

Heaters, Feed Water
Blake & Knowles Steam Pump Works... 11
Green Fuel Economizer Co. 11
Harrison Safety Boiler Works ... 10

Hoisting Drums
Hayward Co... 82

Hoists
American Engineering Co. 80
Brown Hoisting Mchry. Co. 76
Byers Mach. Co., John F.. 80
Clyde Iron Works... 77
Contractors Plant Mfg. Co. 76
Dobbie Fdry. & Mach. Co.. 76
Flory Mfg. Co., S... 77
Ingersoll-Rand Co... 29
Insley Mfg. Co... 69
Koehring Machine Co.... 69
Lansing Co... 71
Lidgerwood Mfg. Co... 77
Mundy, J. S... 77
National Hoisting Engine Co. ... 80
Ransome Concrete Machinery Co... 67
Robins Conveying Belt Co. 78

Hoists, Electric
American Engineering Co. 80
Brown Hoisting Mchry. Co. 76
Contractors Plant Mfg. Co. 75
Dobbie Fdry. & Mach. Co.. 76
Flory Mfg. Co., S... 77
Lidgerwood Mfg. Co... 77
Longenecker & Co., C..83, 85

Hoists, Electric—Continued
Mead-Morrison Mfg. Co... 82
Mundy, J. S... 77
National Hoisting Engine Co. ... 80

Hose, Suction
Edson Mfg. Co... 7

Hydrants
Clow & Sons, Jas. B... 14
Coffin Valve Co... 19
Drummond & Co., M. J.... 14
Glamorgan Pipe & Foundry Co... 14

Inserts for Concrete
Janney, Steinmetz & Co... 86

Instruments, Electrical Measuring
Fort Wayne Electric Wks. 29

Instruments, Drawing
Aloe Co., A. S... 23
Alteneder & Sons, Theo.... 20
Elliott Co., B. K... 22
Gurley, W. & L. E... 22
Keuffel & Esser Co... 21
Soltmann, E. G... 22
Weber & Co., F... 22

Instruments, Recording
Bristol Co., The... 34
Pitometer Co... 34

Instruments, Surveying
Aloe Co., A. S... 23
Alteneder & Sons, Theo.... 20
Ainsworth & Sons, Wm.... 23
Architects & Engineers Supply Co... 22
Berger & Sons, C. L.... 22
Brandis Sons & Co., F. E.. 21
Buff & Buff Mfg. Co... 21
Chicago Steel Tape Co.... 22
Elliott Co., B. K... 22
Gurley, W. & L. E... 22
Hanna Mfg. Co... 22
Heller & Brightly... 22
Keuffel & Esser Co... 21
Kolesch & Co... 21
Lietz Co., A... 22
Soltman, E. G... 22
Weber & Co., F... 21

Instruments, Mathematical
Ainsworth & Son, Wm.... 23
Keuffel & Esser Co... 21

Joints, Flexible Pipe
Coldwell-Wilcox Co.... 19
U. S. Cast Iron Pipe and Foundry Co... 14

Kettles, Asphalt & Tar
Union Iron Works... 84

Lamps, Electric
Fort Wayne Electric Wks. 29
Westinghouse Electric & Mfg. Co... 9

Lamp Posts
Minneapolis Steel & Machinery Co... 97
Parsons Co., G. W... 51

Locomotives, Compressed Air
Baldwin Locomotive Wks. 31
Porter Co., H. K... 31

Locomotives, Contractors
Baldwin Locomotive Works 31
Davenport Locomotive Works ... 30
Porter Co., H. K... 31
Vulcan Iron Wks. (Wilkes-Barre) ...31, 89

Locomotives, Electric
Baldwin Locomotive Wks. 31
Robins Conveying Belt Co. 78
Westinghouse Electric & Mfg. Co... 9

Locomotives, Gasoline
Baldwin Locomotive Works 31

Locomotives, Geared
Baldwin Locomotive Works 31

Locomotives, Industrial
Baldwin Locomotive Wks. 31
Davenport Locomotive Work ... 30
Porter Co., H. K... 31
Robins Conveying Belt Co. 78
Vulcan Iron Wks. (Wilkes-Barre) ...31, 89

Locomotives, Mine
Baldwin Locomotive Works 31

Locomotives, Passenger and Freight
Baldwin Locomotive Works 31

Locomotives, Steam
Baldwin Locomotive Wks. 31
Davenport Locomotive Works ... 30
Porter Co., H. K... 31
Vulcan Iron Wks. (Wilkes-Barre) ...31, 89

Lumber
Talley's Sons, Thos. J..... 86

Meters, Oil & Gas
Buffalo Meter Co... 20
Builders Iron Foundry.... 34
Gamon Meter Co... 19
National Meter Co... 20
Pittsburg Meter Co... 19

Meters, Water
Buffalo Meter Co... 20
Builders Iron Foundry.... 34
Gamon Meter Co... 19
Hess Flume Co... 15
National Meter Co... 20
Neptune Meter Co... 1
Pitometer Co... 34
Pittsburg Meter Co... 19
Simplex Valve & Meter Co. 18
Standard Water Meter Co.. 20

Mixers, Asphalt
Foote Concrete Mchry. Co. 71
Smith Co., T. L... 75

Mixers, Concrete
Chicago Concrete Machinery Co... 69
Foote Concrete Machy. Co. 71
Koehring Machine Co.... 69
Lansing Co... 71
Marsh-Capron Mfg. Co.... 71
Monighan Machine Co.... 84
Municipal Engineering & Contracting Co... 65
Northfield Iron Co... 71
Ransome Concrete Machinery Co... 67
Smith Co., T. L... 75

Mixers (Heated), Asphalt and Concrete
Smith Co., T. L... 75

Mixers, Mortar
Lansing Co... 71

Mixers and Ejectors (Grout)
Ransome Concrete Machinery Co... 67

Molds, Pipe & Culvert
Blaw Steel Centering Co... 53

Motors, Electric
Fort Wayne Electric Wks. 29
Westinghouse Electric & Mfg. Co... 9

Nuts
Cleveland City Forge & Iron Co... 81

Packing, Leather
Detroit Leather Specialty Co. ... 4

Packing, Metallic
Detroit Leather Specialty Co. ... 4
Power Specialty Co... 12

Paints
Barrett Mfg. Co...100
Carbolineum Wood Preserving Co... 87
Hydrex Felt & Engineering Co... 3
Wadsworth-Howland Co... 89

Paints, Metal Protective
Carbolineum Wood Preserving Co... 87
Wadsworth-Howland Co... 89

Paint, Graphite
Dixon Crucible Co., Jos.... 15

Paper, Blueprint
Aloe Co., A. S... 23
Keuffel & Esser Co... 21
Kolesch & Co... 21
Pease & Co., C. F... 22
Soltmann, E. G... 22

Paper, Drawing
Aloe Co., A. S... 23
Keuffel & Esser Co... 21
Kolesch & Co... 21
Pease & Co., C. F... 22
Soltmann, E. G... 22
Weber & Co., F... 21

Pavements
Warren Bros. Co... 30

Paving Blocks, Creosoted Wood
International Creosoting & Construction Works... 87

Paving Blocks, Stone
Leopold & Co., J... 51
Rockport Granite Co... 92

Paving Joint Filler
Barrett Mfg. Co...100

Piles, Concrete
MacArthur Concrete Pile & Foundation Co... 94
Raymond Concrete Pile Co. 95
Underground Construction Co... 95

Pile Drivers
Browning Engineering Co. 81
Contractors Plant Mfg. Co. 76
Goubert, A. A... 87
Industrial Works ... 81
McKiernan-Terry Drill Co. 28
McMyler Interstate Co.... 81
Union Iron Works... 84
Vulcan Iron Works (Chicago) ... 82

Pile-Shoes
Janney, Steinmetz & Co... 86
Vulcan Iron Works (Chicago) ... 82

Piling, Sheet Steel
Carnegie Steel Co... 94
Jones & Laughlin Steel Co. 71
Lackawanna Steel Co.... 2
Wemlinger Steel Piling Co. 94

Piling, Wood
Talley's Sons, Thos. J..... 86

Pipe Contings
Standard Asphalt & Rubber Co... 29

Pipe Covering
American District Steam Co. ... 11
Johns-Manville Co., H. W.. 7
Wyckoff & Son Co., A... 87

Pipe Fittings
American Pipe & Construction Co... 14
Builders Iron Foundry.... 34
Central Foundry Co.... 15
Kellogg Co., M. W... 10
Millar & Son Co., Chas.... 14
Simmons Co., John... 18
United States Cast Iron Pipe & Foundry Co.... 14
Washington Pipe & Fdry. Co. ... 16

Pipe, Iron
Abendroth & Root Mfg. Co. 14
American Cast Iron Pipe Co. ... 14
American Pipe & Construction Co... 14
Central Foundry Co... 15
Clow & Sons, Jas. B... 14
Donaldson Iron Co... 14
Drummond & Co., M. J.... 14
Fox & Co., John... 14
Glamorgan Pipe & Foundry Co... 14
McWane Pipe Works.... 14
Millar & Sons Co., Chas... 14
Simmons Co., John... 18
United States Cast Iron Pipe & Foundry Co.... 14
Wood & Co., R. D... 14

Pipe Jacks
Standard Pipe Jack Co.... 57

Pipe Joint Compounds
Dixon Crucible Co., Jos... 15

Pipe Joint Compounds, Pressure
Leadite Co... 14

Pipe Jointers
Watkins, Thos... 19

Pipe, Riveted Steel
Abendroth & Root Mfg. Co. 14
Carroll-Porter B. & T. Co. 14
Des Moines Bridge & Iron Co. ... 15
Dover Boiler Works... 15
East Jersey Pipe Co.... 19
Norbom Engr. Co... 84
Petroleum Iron Works.... 12
Riter-Conley Mfg. Co.... 98

Pipe Shoes
Marion Malleable Iron Works ... 16

Pipe, Specials
Builders Iron Foundry.... 34
Kellogg Co., M. W... 10
Standard Pipe Jack Co.... 57

Pipe, Steel
Hess Flume Co... 15
National Tube Co... 18

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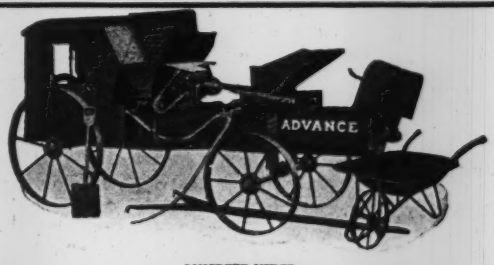

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Jones & Laughlin Steel Company
American Iron and Steel Works
Pittsburgh

80

Pipe, Vitrified Clay
International Clay Products Bureau..... 19
National Fireproofing Co.. 93

Pipe, Wood
Eastern Mfg. Co..... 18
Michigan Pipe Co..... 16
Pacific Tank & Pipe Co.... 57
Portland Wood Pipe Co... 16
Redwood Manufacturers Co. 18
Tacoma Wood Pipe Co... 16
Washington Pipe & Fdry. Co. 16
Wyckoff & Son Co., A..11, 18

Powder
Keystone National Powder Co. 86
Trojan Powder Co..... 86
Waclark Titanite Explosive Co..... 86

Power Transmission Mchry.
Bacon, Earle C..... 33
Guarantee Construction Co. 78
Jones & Laughlin Steel Co. 71
Leffel Co., Jas..... 8
Link-Belt Co..... 81
Morse Chain Co..... 80

Pumps, Air
Buffalo Steam Pump Co.... 73
Cameron Steam Pump Wks., A. S. 73
Deming Co. 6
Laidlaw-Dunn-Gordon Co.. 29

Pumps, Air Lift
Ingersoll-Rand Co..... 29

Pumps, Boiler Feed
Blake & Knowles Steam Pump Works..... 11
Buffalo Steam Pump Co.. 73
Cameron Steam Pump Wks., A. S. 73
Deming Co. 6
Jeanesville Iron Works Co. 8
Keystone Driller & Pump Co. 7
Laidlaw-Dunn-Gordon Co.. 29
McGowan, John H..... 6

Pumps, Centrifugal
American Well Works..... 6
Buffalo Steam Pump Co... 73
Jeanesville Iron Works Co. 8
Lawrence Machine Co..... 6
Longenecker & Co., C....83, 85
Morris Machine Works.... 6

Pumps, Contractors
Buffalo Steam Pump Co... 73
Cameron Steam Pump Wks., A. S. 73
Edson Mfg. Co..... 7
Oshkosh Mfg. Co..... 8
Parker, A. A..... 8
Pulsometer Steam Pump Co. 4

Pumps, Deep Well
American Well Works.... 6
Blake & Knowles Steam Pump Works..... 11
Cameron Steam Pump Wks., A. S. 73
Cook Well Co..... 19
Deming Mfg Co..... 6
Keystone Driller & Pump Co. 7
McGowan Co., John H..... 6

Pumps, Diaphragm
Boston & Lockport Block Co. 79
Deming Co..... 6
Edson Mfg. Co..... 7
Oshkosh Mfg. Co..... 8
Parker, A. A..... 8

Pumps, Dredging
Lawrence Machine Co..... 6
Morris Machine Works.... 6
Norbom Engr. Co..... 84
Parker A. A..... 8

Pumps, Elevator
Laidlaw-Dunn-Gordon Co.. 29
McGowan Co., John H.... 6
Prescott Steam Pump Co., F. M. 4

Pumps, Mine
Aldrich Pump Department. 10
Cameron Steam Pump Wks., A. S. 73
Deming Co. 6
Jeanesville Iron Works Co. 8
Laidlaw-Dunn-Gordon Co.. 29
Morris Machine Works.... 6
Prescott Steam Pump Co., F. M. 4
Pulsometer Steam Pump Co. 4

Pumps, Oil
Cameron Steam Pump Wks., A. S. 73
Deming Co. 6
Jeanesville Iron Works Co. 8
Laidlaw-Dunn-Gordon Co.. 29

Pumps, Tank
Cameron Steam Pump Wks., A. S. 73
Cook Well Co..... 19
Deming Co. 6
Jeanesville Iron Works Co. 8
McGowan Co., John H.... 6
Mietz, August 12
Parker, A. A..... 8
U. S. Wind Engine & Pump Co. 18

Pumps, Triplex
Deming Co. 6

Pumps, Turbine
Deming Co. 6
Jeanesville Iron Works Co. 8
Lawrence Machine Co..... 6

Pumps, Vacuum
Blake & Knowles Steam Pump Works..... 11
Cameron Steam Pump Wks., A. S. 73
McGowan Co., John H..... 6

Pumps, Wind Mill
Cook Well Co..... 19
Deming Co. 6
U. S. Wind Engine & Pump Co. 18

Punches
Wiener Machinery Co..... 33

Purifiers, Drinking Water
Forbes Co..... 97

Purifiers, Feed Water
Booth Co., L. M..... 11
New York Cont'l Jewell Filtration Co..... 51

Rails, Heavy
Carnegie Steel Co..... 94
Hyde Bros. & Co..... 60
Indianapolis Switch & Frog Co. 30
Jones & Laughlin Steel Co. 71
Lackawanna Steel Co..... 2
Sherwood, E. C..... 60

Rails, Light
Orenstein-Arthur Koppel Co. 31
Wiener Co., Ernst..... 30

Rail Benders
Indianapolis Switch & Frog Co. 30

Rail-joints
Carnegie Steel Co..... 94
Indianapolis Switch & Frog Co. 30
Rail Joint Co..... 30

Railways, Industrial
Jeffrey Mfg. Co..... 79
Wiener Co., Ernst..... 30

Railway Track Specialties
Indianapolis Switch & Frog Co. 30

Regulators, Flush Tank Siphon
Pacific Flush Tank Co.... 57

Rivets
Pennsylvania Steel Co..... 98

Riveters, Pneumatic
Chicago Pneumatic Tool Co. 28

Road Oils and Preservatives
Barrett Mfg. Co.....100

Road Rollers
Austin-Western Co..... 33
Buffalo Steam Roller Co.. 32

Rods, Leveling
Chicago Steel Tape Co.... 22

Roofing
Barrett Mfg. Co..... 100
Berger Mfg. Co..... 90
Hydrex Felt & Engineering Co. 2
Johns-Manville Co., H. W.. 7

Roofing, Metal
Youngstown Iron & Steel Co. 96

Rope, Wire
American Steel & Wire Co. 90
Hazard Mfg. Co..... 81
Trenton Iron Co..... 82

Sash, Steel
Detroit Steel Products Co. 3
Trussed Concrete Steel Co., 5

Scarifiers
Acme Road Mchry. Co.... 32
Buffalo Steam Roller Co... 32

Schools and Colleges
See page 27

Scrapers
Lansing Co..... 71

Screens, Rotary
Chicago Concrete Machinery Co..... 69
Jeffrey Mfg. Co..... 79
Smith Co., T. L..... 75

Screens, Sand and Gravel
Clinton Wire Cloth Co..33, 99

Screens, Well
American Well Works.... 6
Cook Well Co..... 19

Second-hand Equipment
Acme Engineering & Contracting Co..... 61
Bannister, E. W..... 61
Braden, Jas. S.....60, 63
Canton-Hughes Co..... 60
Croton Falls Construction Co. 63
Dallett & Co..... 60
Engineering Agency..... 60
Foote-Ehrbar-Wilcox Co... 61
Githens, Geo. S..... 63
Hitner's Sons Co., Henry A. 61
Horton, John T..... 60
Hyde Bros. Co..... 60
Iola Portland Cement Co.. 60
Marine Metal & Supply Co. 60
Mathes Iron & Metal Co., G. 61
McAlbee Powder & Oil Co., G. R. 61
Pipe & Contractors' Supply Co. 60
Seyfert's Sons, L. F..... 61
Sherwood, E. C..... 60
Southern Iron & Equipment Co. 60
Streicher Co., H. P..... 63
Whitney, O. R..... 60
Wilson & Co., E. H..... 60
Zelnicker, W. A..... 60

Separators, Steam and Oil
Harrison Safety Boiler Works 10

Sewer Appliances
Carson Trench Mach. Co.. 51
Pacific Flush-Tank Co.... 57

Sewage Disposal Apparatus
Pacific Flush-Tank Co.... 57

Sewage Presses
Coffin Valve Co..... 19

Sewage Purification Tanks
Pacific Flush-Tank Co.... 57

Shears, Beam
Wiener Machinery Co..... 33

Sheaves
Metaline Co..... 33
Patterson Co., W. W..... 96
Pittsburg Block & Mfg. Co. 96

Shoes, Wood Pipe
Marion Malleable Iron Works 16

Shovels, Steam
Browning Engineering Co. 81
Longenecker & Co., C...83, 85
Thew Automatic Shovel Co. 85

Shutters, Steel and Wood Rolling
Kinnear Mfg. Co..... 73

Sidewalk Forms
Blaw Steel Centering Co... 53
Hotchkiss Lock Metal Form Co. 94

Siphons, Metal
Hess Flume Co..... 15

Skips
Contractors Plant Mfg. Co. 76
Ransome Concrete Machinery Co..... 67

Skylights
Kinnear Mfg. Co..... 73

Sluice Gates
Coffin Valve Co..... 19
Coldwell Wilcox Co..... 19
Smith Co., S. Morgan..... 8

Softeners, Water
Booth Co., L. M..... 11
Harrison Safety Boiler Works 10
New York Continental Jewell Filtration Co.... 51
Roberts Filter Mfg. Co.... 19

Sprinkler Systems, Automatic Fire
General Fire Extinguisher Co. 7

Sprinklers and Oilers (Street)
Studebaker Corporation, The 33

Stacks
Riter-Conley Mfg. Co..... 98

Standpipes
Des Moines Bridge & Iron Co. 15
Dover Boiler Works..... 15
Petroleum Iron Works.... 12
Riter-Conley Mfg. Co.... 98
Schreiber & Sons Co., L... 96
Tippett & Wood..... 12
Virginia Bridge & Iron Co. 97

Steel Plate Construction
Blaw Steel Centering Co... 53
Des Moines Bridge & Iron Co. 15
Dover Boiler Works..... 15
Pennsylvania Steel Co.... 98
Petroleum Iron Works Co. 12
Riter-Conley Mfg. Co..... 98
Smith & Sons, Theo..... 85
Virginia Bridge & Iron Co 97
Williams Co., G. H..... 85

Steel, Structural
American Bridge Co..... 98
Berlin Construction Co... 96
Blaw Steel Centering Co... 53
Carnegie Steel Co..... 94
Des Moines Bridge & Iron Co. 15
Eastern Bridge & Structural Co..... 97
Fort Pitt Bridge Work.... 96
Guarantee Construction Co. 78
Jones & Laughlin Steel Co. 71
Kenwood Bridge Co..... 96
Lackawanna Bridge Co... 95
Massillon Bridge & Structural Co..... 96
McClintic-Marshall Construction Co..... 98
McMyler-Interstate Co.... 81
Milwaukee Bridge Co..... 96
Missouri Valley Bridge & Iron Co..... 97
Mt. Vernon Bridge Co..... 96
Penn Bridge Co..... 97
Petroleum Iron Works Co. 12
Phoenix Bridge Co..... 96
Riter-Conley Mfg. Co..... 98
Riverside Bridge Co..... 96
Scherzer Rolling Lift Bridge Co..... 96
Shoemaker & Co., Lewis F. 96
Worden-Allen Co..... 95

Sterilizers, Drinking Water
Forbes Co..... 97

Strainers, Well
Cook Well Co..... 19

Superheaters, Sten. and Air
Power Specialty Co..... 12

Sweepers (Street)
Studebaker Corporation, The 33

Switchboards and Switches
Fort Wayne Electric Wks. 29
Westinghouse Electric & Mfg. Co..... 9

Tables and Boards, Drawing
American Drafting Furniture Co..... 23
Keuffel & Esser Co..... 21
Soltmann, E. G..... 22
Weber & Co., F..... 21

Tachometers, Recording
Bristol Co..... 34

Tanks and Towers
Carroll-Porter B. & T. Co.. 14
Des Moines Bridge & Iron Co. 15
Dover Boiler Works..... 15
Minneapolis Steel & Machinery Co..... 97
Pacific Tank & Pipe Co.... 16

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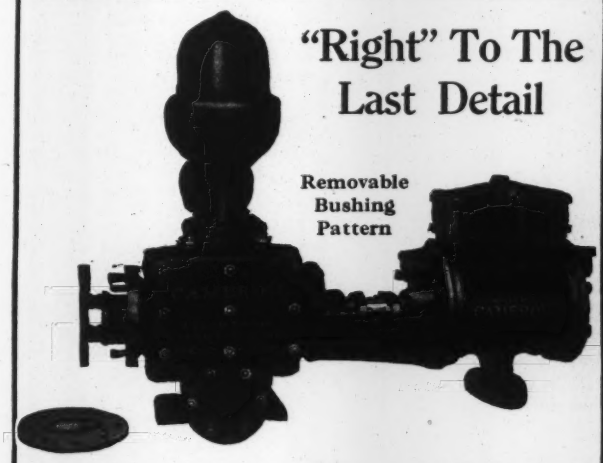

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Highly Standardized, due to large and rapidly growing production. Regularly specified by shrewd pump buyers who know and appreciate quality, prompt service and attractive prices. Let us file our catalogs with you.
DEPT. E.
Buffalo Steam Pump Co.
BUFFALO, N. Y.

Your Idle Machinery

or plant, or tools for which you have no present use might be sold or rented to some other reader through the medium of a "For Sale or Rent" advertisement in ENGINEERING NEWS.

Rates on Application

The Miller Siphon
For Flushing Sewers

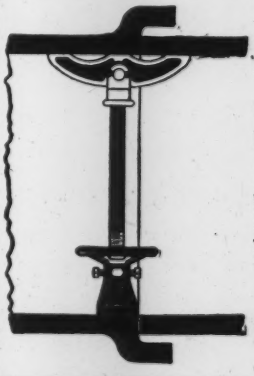
TAYLOR NOZZLES and RISERS

SEWAGE DISPOSAL AIR-LOCK CONTROLS

Send for Catalog

Write for Discount

Pacific Flush-Tank Company
Chicago New York
Representatives IMHOFF Patented TANKS



LAY PIPE

FASTER BETTER CHEAPER WITH A

PIPEJACK

Does away with wedges and blocking. You'll do a better job and do it in less time. Look it over.

STANDARD PIPE JACK CO.
HOLYOKE, MASS.

WESTERN ADVERTISERS

may have their **WANT** and **FOR SALE** Advertisements **KEYED TO OUR**

Chicago Office, 1138 Monadnock Block

and in that way save considerable time in forwarding.

Want Ads received at our Chicago Office on the Saturday preceding publication will be inserted in classification.

Tanks and Towers—Cont.
Petroleum Iron Works Co. 12
Riter-Conley Mfg. Co..... 98
Tippett & Wood..... 12
Virginia Bridge & Iron Co. 97

Tanks, Wood
Pacific Tank & Pipe Co... 16
Redwood Manufacturers Co. 18

Tapes, Steel and Metallic
Chicago Steel Tape Co.... 22
Keuffel & Esser Co..... 21
Lufkin Rule Co..... 22

Telpherage Systems
Brown Hoisting Mchry. Co. 76

Testing Laboratories
See pages 26, 27

Ties, Steel
Carnegie Steel Co..... 94
Jones & Laughlin Steel Co. 71

Tile, Concrete Building
Trussed Concrete Steel Co. 5

Tools, Pneumatic
Chicago Pneu. Tool Co.... 28

Towers, Hoisting
Dodge Co., J. M..... 78

Track, Portable
Orenstein-Arthur Koppel Co. 31
Wiener Co., Ernst..... 30

Tramways
Dodge Co., J. M..... 78
Trenton Iron Co..... 82

Transformers, Electric
Fort Wayne Electric Wks. 29

Transmission Towers, Galvanized
Riter-Conley Mfg. Co..... 98

Treads, Safety
Concrete Steel Co..... 97

Trenching Machinery
Austin Drainage Excavator Co., F. C.....49, 55
Carson Trench Machine Co. 51
Municipal Engineering & Contracting Co..... 65
Parsons Co., G. W..... 51

Trolley Poles, Steel
Franklin Steel Co..... 92

Trucks, Hand
Lansing Co..... 71

Tubing, Steel
National Tube Co..... 18

Turbines, Water
Leffel & Co., Jas..... 8
Smith Co., S. Morgan..... 8

Turnbuckles
Cleveland City Forge & Iron Co..... 81
Merrill Bros..... 80
Wiener Co., Ernst..... 30

Turntables
Lansing Co..... 71
McMyler Interstate Co.... 81
Pennsylvania Steel Co.... 98

Typewriters
Blickensderfer Mfg. Co.... 20

Unions
National Tube Co..... 18

Valves—Water, Steam, Gas
Coffin Valve Co..... 19
Harrison Safety Boiler Works 10
Kellogg, M. W..... 10
National Tube Co..... 18
Simmons Co., John..... 18
Smith Co., S. Morgan..... 8

Ventilating Apparatus
Detroit Steel Products Co. 3
Sullivan Machinery Co.... 28

Vises
Merrill Bros.. 70

Wagons, Dump
Austin-Western Co..... 33
Columbia Wagon Co..... 32
Eagle Wagon Works..... 33
Studebaker Corporation, The 33
Troy Wagon Works..... 32
Watson Wagon Co..... 53

Wagons, Garbage
Studebaker Corporation, The 33
Watson Wagon Co..... 53

Washers, Leather
Detroit Leather Specialty Co. 4

Waterproofing
Barrett Mfg. Co.....100
Carbolineum Wood Preserving Co..... 87
Hydrex Felt & Engineering Co..... 3
Neuchatel Asphalt Co..... 29
Sicilian Asphalt Paving Co. 30

Waterproofing—Continued
Standard Asphalt & Rubber Co..... 29
Wadsworth-Howland & Co. 89

Well Drilling Machines
American Well Works.... 6
Keystone Driller Shops... 29

Wheelbarrows
Lansing Co..... 71

Wheels
Carnegie Steel Co..... 94
Taylor Iron & Steel Co.... 12

Winches
Dobbie Fdry. & Mach. Co. 76
Lidgerwood Mfg. Co..... 77

Windows, Steel
Detroit Steel Products Co. 3
Trussed Concrete Steel Co 5

Wires and Cables
American Steel & Wire Co. 90
Hazard Mfg. Co..... 81
Trenton Iron Co..... 82

Wire Cloth
Clinton Wire Cloth Co..33, 99

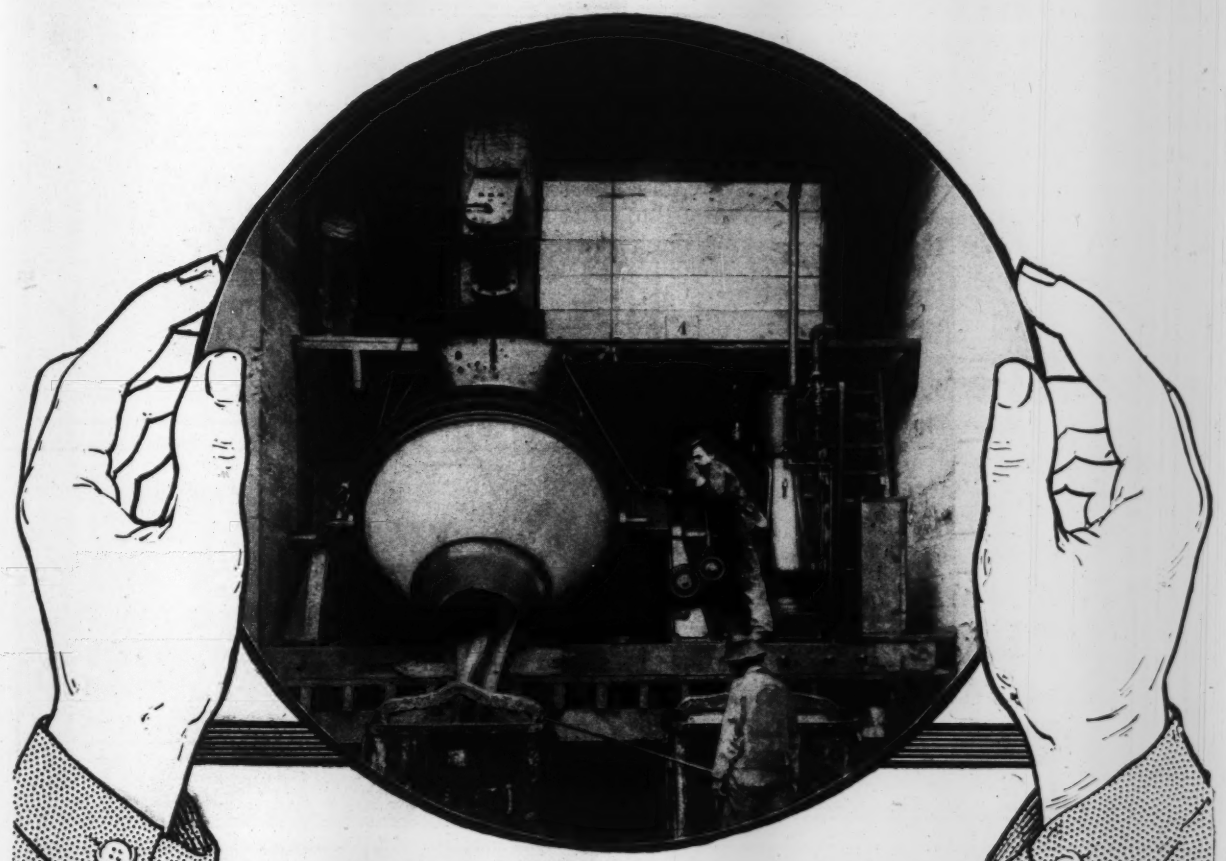
Wood Preserving
Atlantic Creosoting & Wood Preserving Works. 87
Barber Asphalt Paving Co. (Maurer) 87
Cabot, Inc., Samuel..... 97
Carbolineum Wood Preserving Co..... 87
International Creosoting & Construction Co..... 87
Wyckoff Pipe & Creosoting Co..... 87

Every Real Accomplishment In Advertising Is The Result Of A Plan

THE haphazard method of "buying space" at the earnest solicitation of the gentlemanly advertising man is like random shooting into the air in the hope that something will fly into the bullet.

¶ When an advertising man can offer you a definite *service*, give you a *plan* for an entire campaign, the space he has for sale is but the conveying medium for a result-bringing idea.

¶ This is the basis upon which advertising space is sold in this paper.



Look At That Concrete

It sure makes the contractors proud to see that Smith Mixer at work. They are putting in a splendid structure. They are ahead of schedule and beating the estimates. The job is the KEOKUK DAM with its 550,000 yards of concrete. The contractors are the Stone & Webster Engineering Corporation of Boston. The mixer is one of the nine big fellows—No. 16 size, 1½ yard wet capacity, with engine and power tilt. They have been plugging away for over a year on this immense job—every one working with clock-like regularity—every one giving the big output and the reliable service that the contractor *always gets* with

SMITH MIXERS

All of which is not surprising, for the Smith double-conical drum is the *natural* mixer, just as the tilting discharge is the logical method of emptying it. Try to imagine some better way of producing concrete. You empty a bucket by tipping it upside down. *That* is the Smith tilting discharge. To mix a fluid mass, you naturally select a revolving drum, small at the ends and big at the center, because only such a drum will create the necessary end-to-center, averaging movement of the elements. *That* is the Smith double conical drum. And there you are—where mixer logic starts and ends—with the Smith Mixer.

Write for Catolog No. 51.

The T. L. SMITH COMPANY

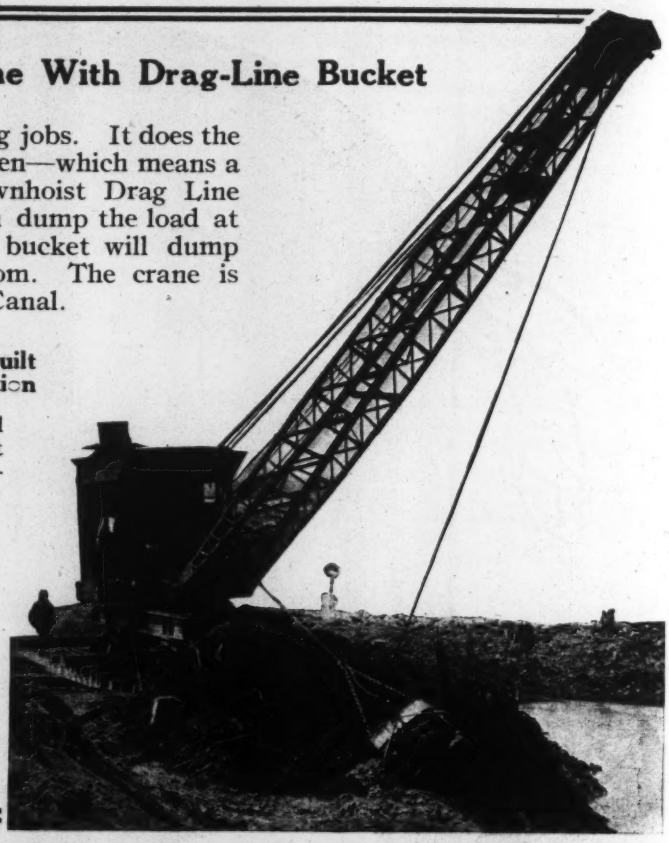
1302 MAJESTIC BUILDING, MILWAUKEE, WISCONSIN

OLD COLONY BUILDING, CHICAGO, ILLINOIS

W. J. Cullen, 30 Church St., New York, N. Y.
Harwell Place, Near 605 Marietta St., Atlanta, Ga.
J. Jacob Shannon & Co., 1744 Market St, Philadelphia, Pa.
Kirk Supply Co., 1739 Liberty Ave., Pittsburg, Pa.
Sherburne & Co., 53 Oliver St., Boston, Mass.

Brownhoist Locomotive Crane With Drag-Line Bucket

is being used today on large excavating jobs. It does the work rapidly and with only several men—which means a low cost per yard. With the Brownhoist Drag Line Bucket the operator of the crane can dump the load at and point along the boom—or the bucket will dump automatically at the end of the boom. The crane is shown here on the New York Barge Canal.



The Brownhoist Crane and Bucket are built for a severe service and continuous operation

Records show where the crane has been used day and night for months at a time without stopping for repairs. This appeals to contractors because loss of time is expensive.

We furnish this equipment up to 100 ft. booms and 3½ yd. bucket.

Write for detail information.

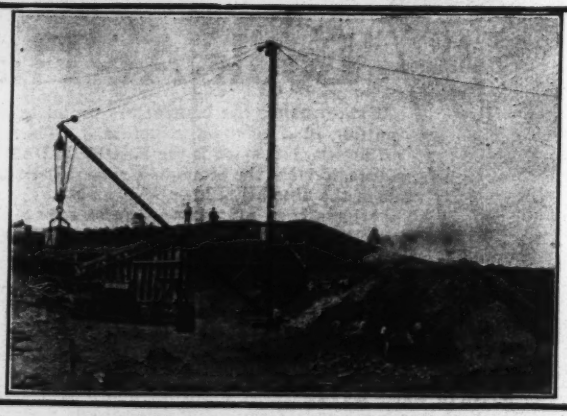
The Brown Hoisting Machinery Co.
Cleveland, Ohio.

New York Pittsburgh
Chicago San Francisco

DOBBIE DERRICKS

All types and capacities stationary and portable for general hoisting and for bucket work, and hoists for the operation of same.

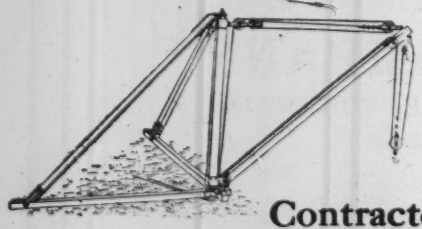
Illustration shows 60 ft. mast, 55 ft. boom, timber derrick with bottom dump bucket, back filling a bridge abutment on Section 77, N. Y. State Barge Canal. T. A. Gillespie Co., Contractors.



DOBBIE FOUNDRY AND MACHINE CO.
Niagara Falls, N. Y.

Branch Stores, Pittsburgh and New York
Western Representatives, Geo. B. Carpenter & Co., Chicago

If you have a contract and want material let us know and our engineering department will help you out.



Thirty years experience which we have had should mean something to you. There are SATISFIED CONTRACTORS all over the country using our Steam and Electric Hoists and Derricks.

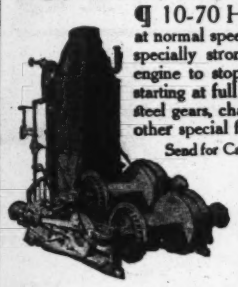
Send for catalog.

Contractors' Plant Mfg. Co., 129 Erie Street, Buffalo, N. Y.

SALES AGENCIES—John T. Horton, 90 West St., New York, N. Y. Henry T. Peirce, Bulletin Bldg., Philadelphia, Pa.
Perrin, Seamans & Co., Boston, Mass. Wimo Supply Co., Spokane, Wash. L. M. Rumsey Mfg. Co., St. Louis, Mo.

THIS CLYDE DOUBLE DRUM DOUBLE CYLINDER HOIST

is particularly adapted to general contracting work.



¶ 10-70 H. P. Load-capacity on a single line at normal speed 2500 to 13000 pounds. Cranks made specially strong and set at right angles---impossible for engine to stop on dead center; this feature also permits starting at full speed. ¶ Hoist has specially large boiler, steel gears, changeable steel ratchets, bronze bushings, and other special features not on other makes.

Send for Catalog F for hundreds of hoists of CLYDE quality.

Chicago Ill. *New York City* CLYDE IRON WORKS DULUTH, MINN. *New Orleans* *Savannah* *Houston*

Established 1870

J. S. MUNDY

Manufacturer of High Class

HOISTING ENGINES, STEAM BOILERS, ETC.

of all Descriptions for Mud Dredging, Bridge Erecting, Pile Driving, Logging, Mining and Quarrying, Steam, Electric and Gasoline.

Home Office, 22 to 34 Prospect St., Newark, N. J., U. S. A.

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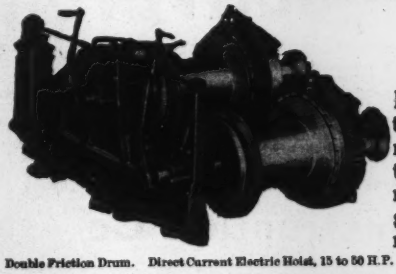
1744 Market St., Philadelphia, Pa.
327 Water St., Pittsburg, Pa.
224 Water St., Norfolk, Va.
28 Light St., Baltimore, Md.
Market and Randolph Sts., Chicago, Ill.
383 Atlantic Ave., Boston, Mass.
210 Washington St., St. Louis, Mo.
29 First St., Portland, Oregon.
203 W. Pearl St., Cincinnati, O.
Garfield Bldg., Cleveland, O.

☜ New Patent Derrick Swinging Engine

LIDGERWOOD HOISTING ENGINES



STEAM and ELECTRIC

Built to meet the requirements of contractors, railroads and general derrick work.

Double Friction Drum. Direct Current Electric Hoist, 15 to 50 H.P.

Lidgerwood Mfg. Co., 96 Liberty St., N. Y.

Flory Hoisting Engines

STEAM and ELECTRIC

For Contractors, Builders, Pile Driving, Logging, Coal Mines, Quarries and general duty.

Cableways Dredge Machinery

all made to duplicate. Material tested in our laboratory, and guarantee satisfaction.

Write for 1910 Catalog

PATENT BOOM SWINGER Simple and Efficient

S. FLORY MFG. CO., Bangor, Pa.

BELTING that proves itself best for a mixing machine has proved itself best for any job where moisture must be considered.

Naturally waterproof materials are, through different resaons, unsuitable for power transmission. *Leather is the only right material to use for belts.*

Schieren's Duxbak Waterproof Leather Belting is "Man Made" waterproof, forming a combination of the most suitable material with a most necessary virtue.

Our price list and guarantee will interest you.

Send us a postal and you'll have it by return mail.

DUXBAK BELTING TRADE MARK

Chas. A. Schieren Company ESTABLISHED 1866

Tanners, Belt Manufacturers

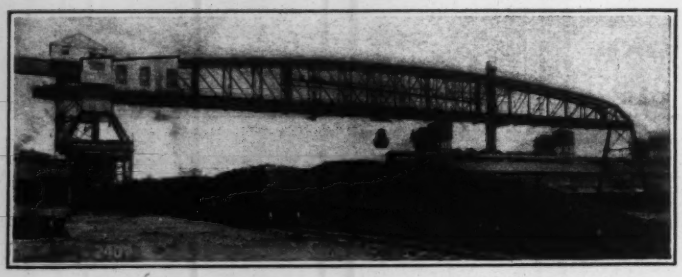
New York, 300 Ferry Street

Chicago, 128 W. Kinzie St.
Boston, 641-643 Atlantic Ave., Opposite South Station.
Philadelphia, 226 South Third St.
Pittsburg, 205 Wood St.
Denver, 1752 Arapahoe St.
Brooklyn, N. Y., Cor. 13th St. and 3d Ave.
Hamburg, Germany, Auf dem Sande 1.

Oak Leather Tanneries, Bristol, Tenn.

COAL STORAGE PLANTS

Designed and Built to suit the conditions and to handle coal with greatest efficiency and economy.



Electrically-Operated Pivoted Bridge-Tramway

The illustration shows the 280-foot span, at the Maryland Steel Company's plant, Sparrow's Point, Md. The bridge swings over a semi-circular area and commands a storage of 50,000 tons of run-of-mine bituminous coal.

Write for Catalog

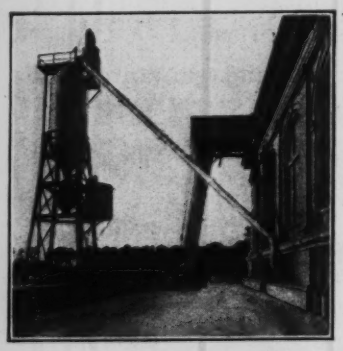
The J. M. Dodge Company

Contracting Engineers

New York, 299 Broadway
Pittsburgh, 1501-3 Park Bldg.

Nicetown, Philadelphia

Chicago, 39th St. and Stewart Ave.
Seattle, 439-440 New York Block



DARLEY SUCTION ASH CONVEYOR

SOME SIGNIFICANT CONTRACTS

Aeolian Company
American Smelting & Ref. Co.
American Steel & Wire Co.
American Woolen Co.
American Writing Paper Co.
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General Electric Co. (2)
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New South Wales Govt. Rys.
Pierce Arrow Motor Car Co. (2)
Taylor Iron & Steel Co.
Standard Oil Co.
United States Government (5)

Guarantee Construction Co.

CONTRACTING ENGINEERS

201 Devonshire Street BOSTON
90 West Street, NEW YORK

Ashes Skip Hoist

Steam Electric Hydraulic Pneumatic

HIGH CAPACITY

THE CHEAPEST
to
INSTALL, OPERATE
and MAINTAIN

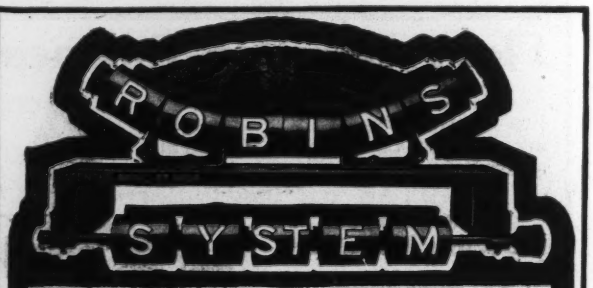
WRITE FOR PRICES
AND SPECIFICATIONS

PHILADELPHIA
Drexel Bldg.

BOSTON
Oliver Bldg.

Write for Catalog.

R. H. BEAUMONT CO.



Conveying, elevating and hoisting machinery, Robins Coal and Coke Crushers. We carry a complete stock of chains and sprockets. Write for monthly bulletins.

ROBINS CONVEYING BELT CO., 13 Park Row, New York

Unusual Conditions Where GANDY Has Proven So Successful

Read this convincing letter from one user.

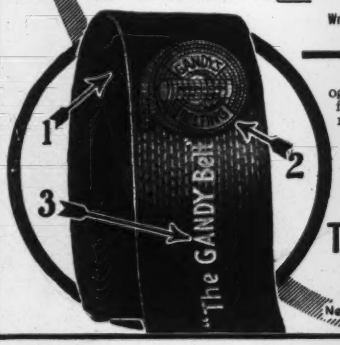
Gentlemen:—
We have two GANDY Main Driving Belts working under peculiar conditions. We require the belts to slip when overloaded. The Gandy Belts meet our requirements, and are as good as ever. Leather belts working under like conditions would soon be destroyed by the heat generated in slipping.
Yours very truly, The Scranton Button Co.
(Signed) P. L. Sylvester, Supt.

The many letters we receive along this line show how serviceable the Gandy is under extraordinary conditions, and convinces us it will prove itself to be the most durable and economical belting for your work.
Remember

The Gandy Belt

is made by the largest manufacturers of stitched cotton duck belting in the world, backed by more than thirty years of success.
We want you to give the Gandy a trial—let us prove just what it will do for you.

Write today for samples, prices and full information.



How you can always recognize Gandy Belting. Look for these three identifying marks:
1st—The Green Edge.
2nd—The Trade Mark.
3rd—The Brand—The Gandy Belt.

The Gandy Belting Co.
735 W. Pratt St.
Baltimore, Maryland
New York Office-88-90 Reade St.

STIFF LEG HEAD BLOCK

of Latest Pattern
Note how simply it is attached to mast
Patented by
THE TERRY & TENCH COMPANY, Inc.
Room 1044, Grand Central Terminal, New York

Star Brand Blocks

Are Standard

If you are in the market for blocks of any description—for hoisting one or one hundred tons—it will save you money to write,
Boston & Lockport Block Co.,
108 Condor Street East Boston, Mass.

WHEN BUYING A CRANE CONSULT THE SPECIALIST
We build **Locomotive Cranes** only
THE OHIO LOCOMOTIVE CRANE CO.
MANSFIELD STREET. BUCYRUS, OHIO

When you are in a hurry for an engineer, surveyor, draftsman, or in fact any technical man, a Situation Open ad. in ENGINEERING NEWS will place you in touch with the largest number of men in the shortest time. Advertisements received Wednesday morning will be inserted in the Situation Open columns of the issue of the following week.

Where Excessive Wear, Renewal of Parts, and Expensive Breakdowns Are Factors to Be Overcome

Manganese Steel Chains, Sprockets and Spiral Conveyers are unequalled.

Especially adapted for handling raw materials in Cement Mills, Fertilizer Works, Ashes, Coke, Rock and other gritty or abrasive materials which come in contact with them.

Comparative tests show that Manganese Steel possesses 50% greater tensile strength and 100% greater wearing qualities than Malleable Iron.

Attachments are interchangeable with those of the Standard Malleable Detachable and Steel Bar and Malleable Chain.

Write for complete information, prices, etc.

Our New General Catalog No. 82 shows a most complete Line of Chains and Attachments for every conceivable Elevating and Conveying purpose, containing many full size illustrations.

Mailed on request to intending purchasers only.

JEFFREY MFG. CO.
Columbus, O.

New York
Boston
Montreal
Pittsburgh
Charleston, W. Va.
Atlanta, Ga.
Birmingham
Chicago
St. Louis
Denver
Seattle

6-27-12

INCREASE the output of your shop by increasing the efficiency of each machine.

Possibly your present power facilities are O. K. Then, all you need in new equipment is a

system of transmitting power from the motors or shafting to the machines.

Morse Silent Chains will increase the efficiency of your machines because they lose less power in transmission. At whatever speed desired to run any machine, maximum power is always available.

Morse Silent Chain Driving Lathe

Morse Silent Chains are used in all kinds of shops all over the country, always with entire satisfaction and most economical results.

Poor machines are made good, and good machines better by Morse Silent Chain Drive.

Write for the Bulletin No. 1111.

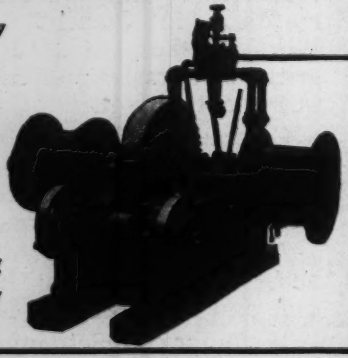
Morse Chain Company, Ithaca, N. Y.

A36

DERRICK SWINGING ENGINES

For Light and Heavy Duty Derricks

STEAM AND ELECTRIC HOISTS AND DERRICKS



National Hoisting Engine Company
Harrison, N. J.

SAFETY AND CONVENIENCE

One of our Hoisting Engines with our wood guide material elevator makes a complete and economical outfit for any contractor.

Light and very compact, making them the ideal engines for transporting from place to place.

We also make Derrick Cars, Derrick Irons, Hand Powers, Blocks and Sheaves. Material Elevators, etc., for every purpose.

Write for complete catalog.

The John F. Byers Machine Co.
RAVENNA, OHIO

WILLIAMSON CONTRACTORS' HOISTS

WITH THE PERFECT DRUM MECHANISM

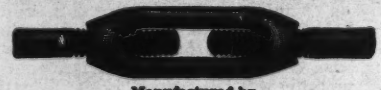
STEAM AND ELECTRIC

AMERICAN ENGINEERING COMPANY
MACHINISTS AND FOUNDERS
PHILADELPHIA, PA.

SEND FOR CATALOG Z

Thomas Carlin's Sons Co.
1600 River Avenue, N. S., Pittsburgh
Hoist Derricks, Engines, Boilers, Pumps and Contractors' Machinery

The "ONE-PIECE" Turnbuckle



Manufactured by
MERRILL BROTHERS Maspeth, New York City

THE McMYLER INTERSTATE CO.

New York CLEVELAND, OHIO Chicago

LOCOMOTIVE CRANES

40 Ton Crane Used in Bridge Erection

Locomotive Cranes
For All Classes of Service

The Industrial Works line of Locomotive Cranes comprises types suitable in every way to give best service on any class of engineering work.

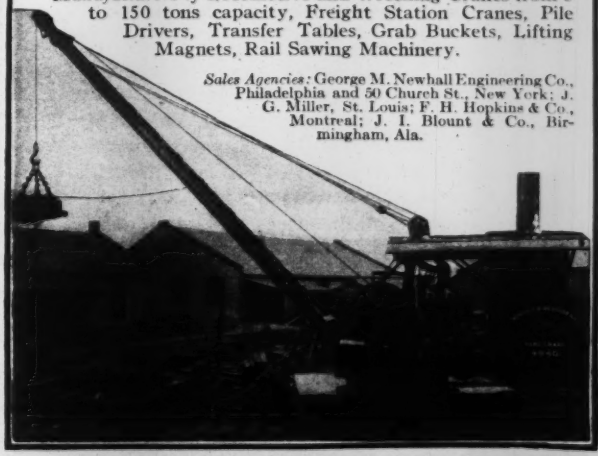
The cranes described in our catalog range from 5 tons to 150 tons capacity, and represent the experience of years spent in the manufacture and development of this class of machinery.

Your most careful investigation is invited, and we'll gladly send our catalog on request.

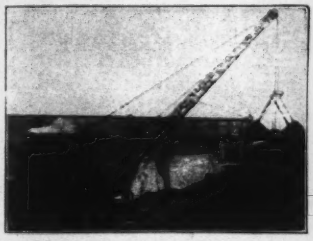
INDUSTRIAL WORKS
BAY CITY, MICHIGAN

Mcnufacturers of Locomotive and Wrecking Cranes from 5 to 150 tons capacity, Freight Station Cranes, Pile Drivers, Transfer Tables, Grab Buckets, Lifting Magnets, Rail Sawing Machinery.

Sales Agencies: George M. Newhall Engineering Co., Philadelphia and 50 Church St., New York; J. G. Miller, St. Louis; F. H. Hopkins & Co., Montreal; J. I. Blount & Co., Birmingham, Ala.



LINK-BELT CRANES



are the Most Easily Operated, Durable, Accessible, Simple and Efficient Cranes on the Market Today.

Write for catalog No. 128

Link-Belt Company, Philadelphia, Chicago Indianapolis

New York, 299 Broadway
Boston, 131 State Street
Buffalo, 601 Ellicott Square
Pittsburgh, 1501-3 Park Bldg.
St. Louis, Central Nat'l Bank Bldg.
Seattle, 118 King Street
Denver, Lindrooth, Shubart & Co.
San Francisco, Eby Machinery Co.
New Orleans, Wilmot Machinery Co.

"HAISS" CONTRACTORS' TYPE
CLAM SHELL BUCKETS
Made Entirely Of Steel

Digging qualities superior owing to shape of shell and increased leverage. Adapted for handling sand, gravel, broken stone, coal, excavating when equipped with teeth. Used by largest R. R. and contractors. *Send for Catalog "B."*

GEO. HAISS MFG. COMPANY, Inc., 142d and Rider Ave., New York City
Southern Agent, T. L. Smith, Atlanta, Ga.

HAZARD
WIRE ROPE
FOR EVERY PURPOSE

HAZARD MFG. CO.
50 Dey Street
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21 Conestoga Bldg.
PITTSBURG, PA.
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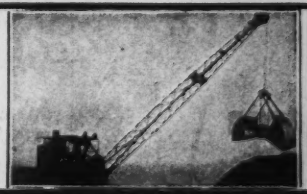

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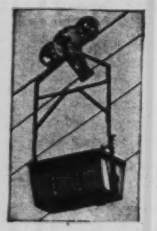

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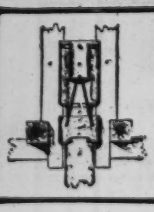

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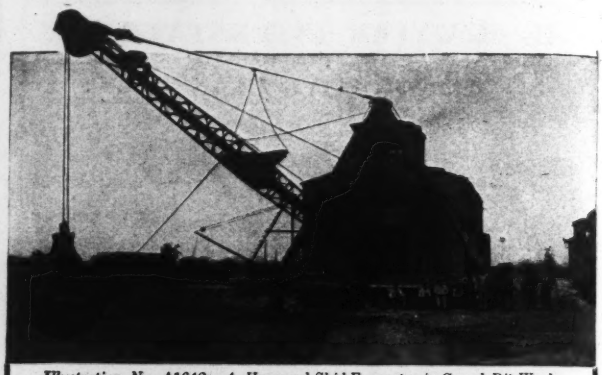

Illustration No. A1642—A Hayward Skid Excavator in Gravel Pit Work, Operated by the Vandalia Railroad Co. at Terra Haute, Ind.

ANOTHER RECORD—275,000 cu. yds. Handled Yearly by this Hayward Skid Excavator

When new rehandling or digging records are made—it is usually a Hayward Bucket that makes them. When speed is imperative and the work must be finished ahead of time, Hayward Buckets "get away" with the work. This

HAYWARD SKID EXCAVATOR

shown above, dug 275,000 cu. yds. of gravel in one year.

The 2½ cu.yd. Orange Peel Bucket, operated on a 65 ft. steel boom, worked to a depth of 40 ft. below ground level, cutting a strip 50 ft. wide.

The gravel was dug from pit and transferred to waiting cars which in turn hauled it two miles to storage. Eight cars were loaded per hour, making an average of 2,000 cu.yds. daily and the net cost was 8c. per cu.yd. loaded and placed at a storage point two miles distant. A remarkably low cost for digging and storing gravel, considering that the cost of hauling by rail is included, it being impossible in this case to separate the cost of hauling from the actual work done by the Excavator.

We design and build these machines from 2½ cu.ft. up to any size desired. Illustration No. A1373 shows one of our small machines operated by gasoline engine. Skid machines of these general types can, by minor changes, be used for a variety of purposes—as a Skid Machine, as a Dredge, as a Traveling Derrick, as a Traveling Excavator, etc.

Hayward Buckets when used on various classes of operating rigs and Hayward Machinery will be found wherever greatest efficiency, speed and absolute reliability are desired.

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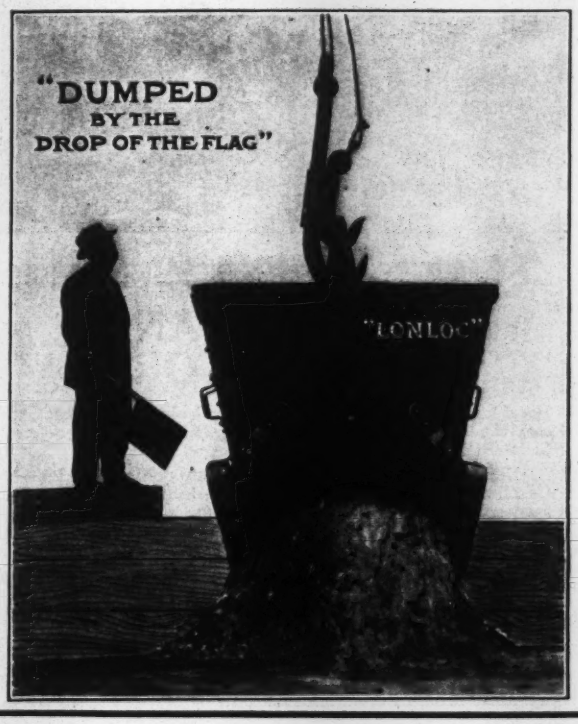

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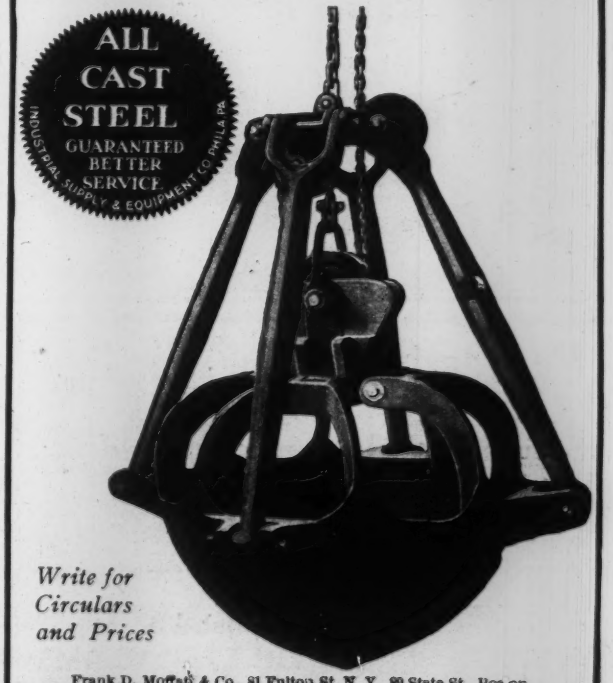

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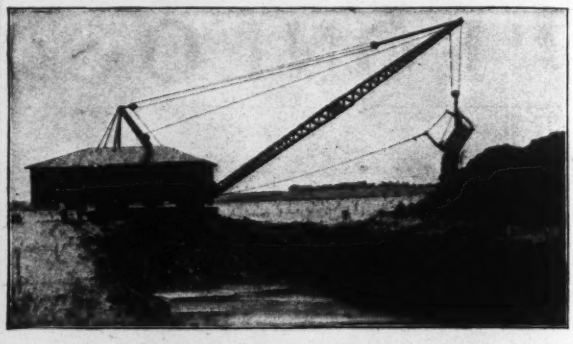

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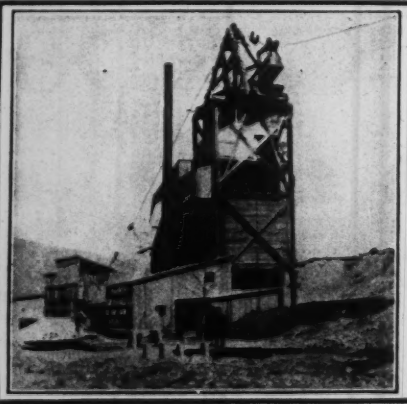

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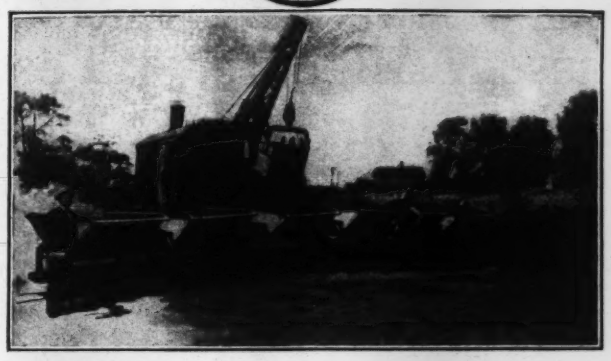

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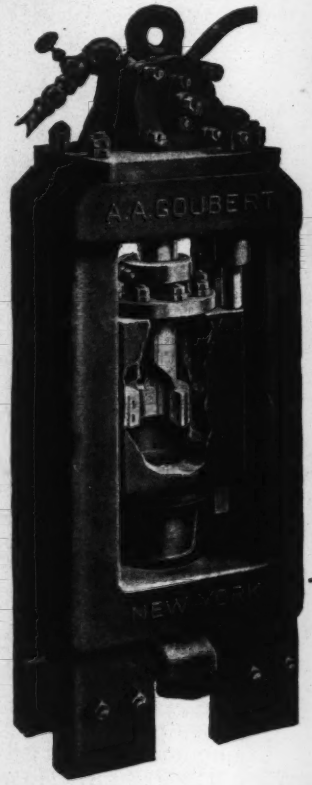

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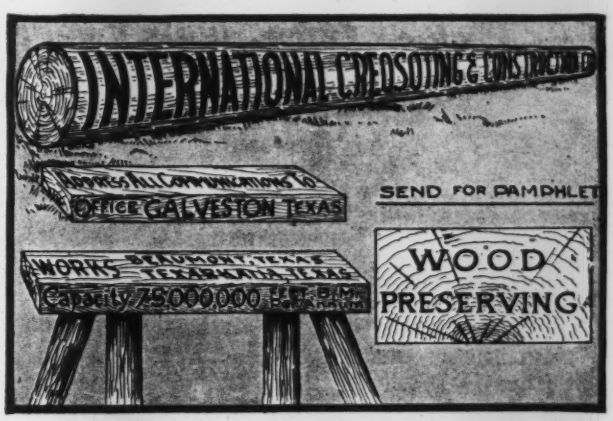

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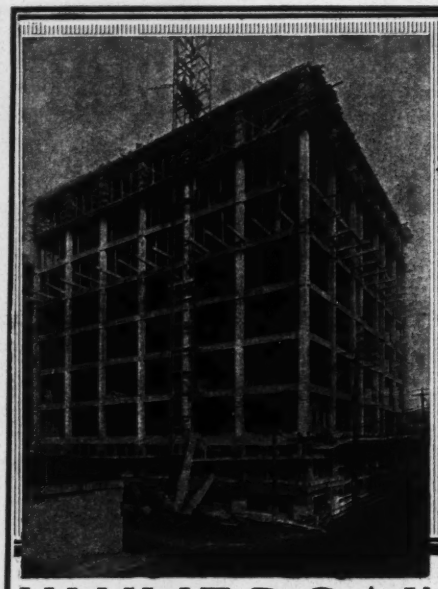

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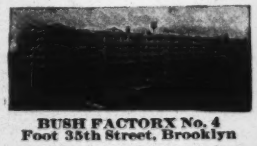

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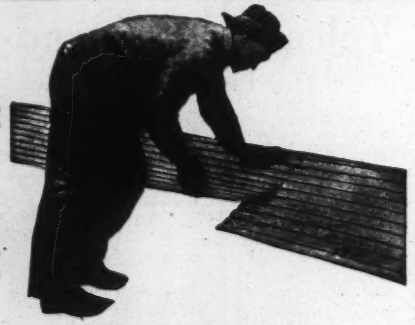

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The scope of the Cement Gun can be described as almost without limit in its application. Results that are impossible by hand work become not only possible but perfect by the use of the Cement Gun.

As a bare outline of its application we would mention the protection of steel in buildings, the protection of bridges and trusses against corrosion from locomotive exhaust, the securing of loose or sliding rock and the plugging of springs in cuttings, the lining of tunnels and pipe conduits, the lining of canals in loose ground, the paving of slopes in earth embankment, the water-proofing of cellars and damp locations generally, the building of concrete houses in competition with wood, the rejuvenation of old houses by virtual conversion into concrete exteriors, the waterproofing of cement-block houses, the exterior finish of walls laid up in terra cotta tiling, the preservation of crumbling brick walls, the surfacing of paved highways, the lining of steel ships or barges, the building or lining of tanks, towers, conduits, etc., and in general the execution of any class of cement work that must be proof against the disintegrating action of frost, sea water, acid solutions or corrosive fumes, etc., etc., etc.

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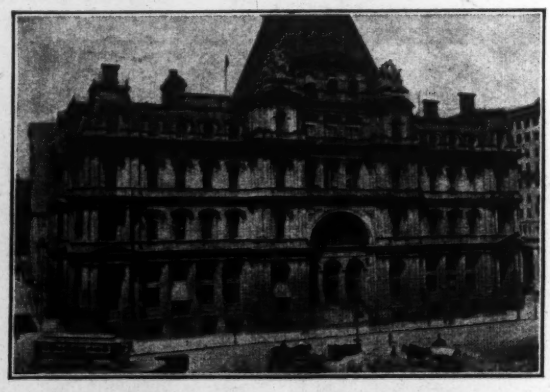

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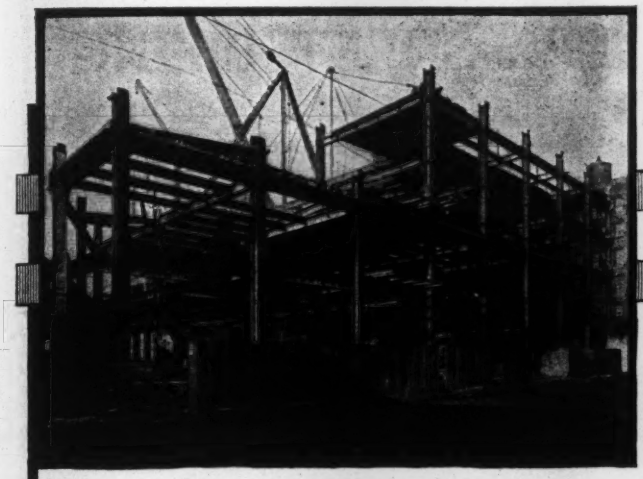
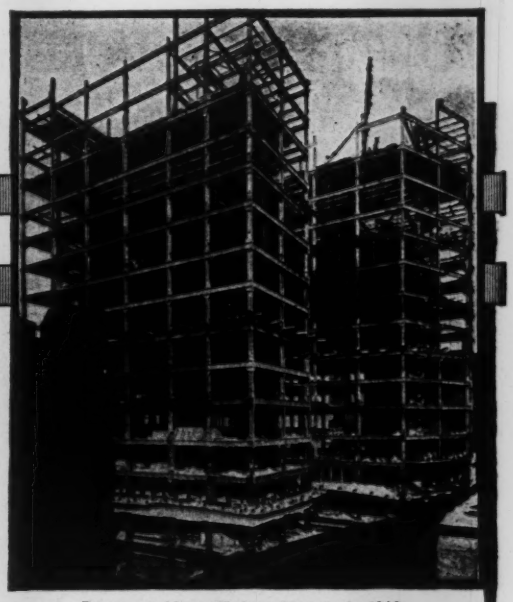


Marshall & Fox, Architects

James Stewart & Co., Contractors.

Progress View Taken Jan. 19, 1912



Progress View Taken March 1, 1912

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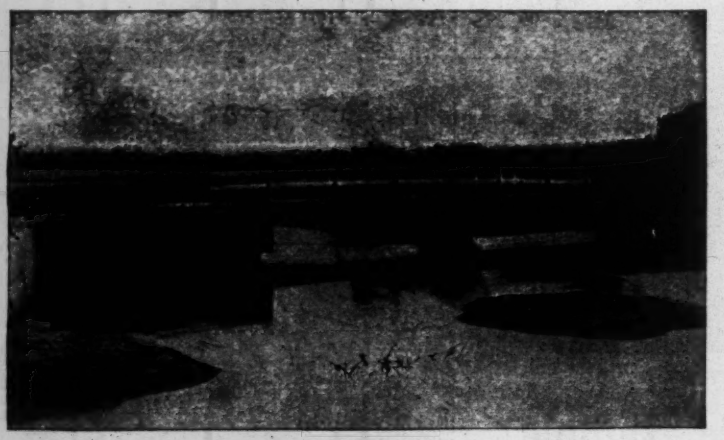

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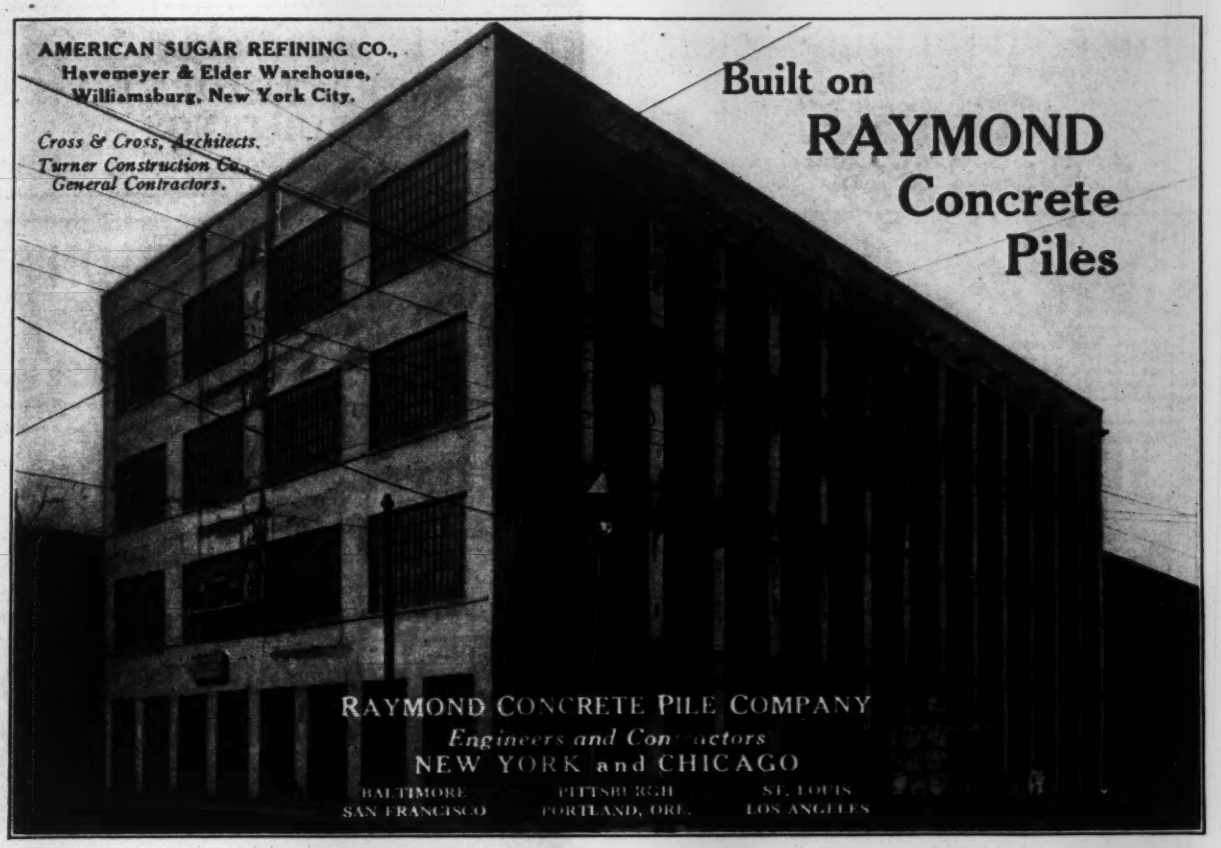

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November 22, 1898
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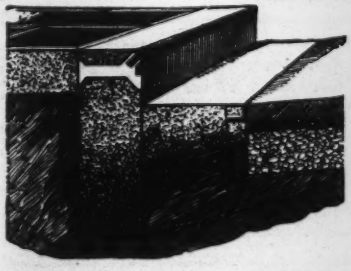

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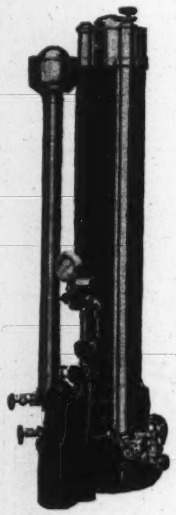

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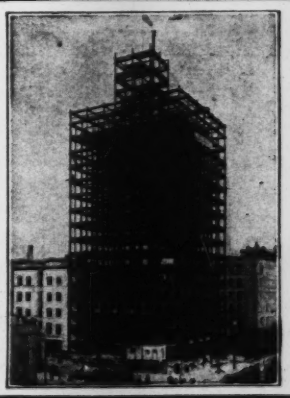

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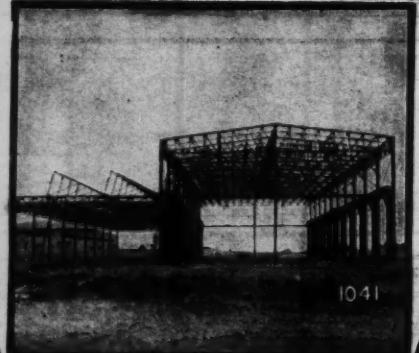

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